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From the Library of the
Fogg Museum of Art
Harvard University

The Revd J. K. Cummin,
With the Author's kind regards —

THEOPHILI,

QUI ET

RUGERUS,

PRESBYTERI ET MONACHI,

LIBRI III.

DE DIVERSIS ARTIBUS:

SEU

DIVERSARUM ARTIUM SCHEDULA.

OPERA ET STUDIO

R. HENDRIE.

LONDINI:
JOHANNES MURRAY, ALBEMARLE STREET.

1847.

AN ESSAY

UPON VARIOUS ARTS,

IN THREE BOOKS,

BY

THEOPHILUS,

CALLED ALSO

RUGERUS,

PRIEST AND MONK,

FORMING AN

ENCYCLOPÆDIA OF CHRISTIAN ART

OF THE ELEVENTH CENTURY.

TRANSLATED, WITH NOTES,

BY

ROBERT HENDRIE.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.

1847.

FOGG ART MUSEUM
HARVARD UNIVERSITY

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cop. 2.

LONDON:
GEORGE WOODFALL AND SON,
ANGEL COURT, SKINNER STREET.

1.

Incipit prologus libri primi
Theophili qui et Rugerus, De diversis artibus.
Theophilus humilis presbyter servus servorum
dei, indignus nomine et professione monachi,
omnibus mentis desidiam animique vagationem
utili manuum occupatione et delectabili novitatum meditatione declinare et calcare volentibus retributionem
celestis premii.

2.

De temperamento colorum in nudis corporibus.
Color qui dicitur membrana, quo pinguntur facies et nuda corpora, sic componitur. Tolle cerosam, id est album quod fit ex plumbo, et mitte eam non tritam, sed ita ut est sicca, in vas cupreum vel ferreum, et pone super prunas ardentes.

3.

Incipit prohemium metricum sequentis operis --
Sensim per partes discuntur quelibet artes -
Artis pictorum prior est factura colorum -
Post ad mixturas constat mente tua curas -
Hoc opus exerce sed ad unguem cuncta cohercere
Ut sit ad ornatum quod pinxeris et quasi natum.
Postea multorum documentis ingeniorum -
Tuo opus augebit. Sicut liber iste docebit.

N.°1. Fac-Simile of the Vienna Manuscript.
N.°2. do. of the Harleian Manuscript.
N.°3. do. of the Paris Manuscript.

Theophili,

qui et Rugerus,

Presbyteri et Mon[illegible]

Libri III [illegible]

De diversis [illegible]

—

Opera [illegible]

Roberti [illegible]

Lo[illegible]n[illegible]

Iohan[illegible] [illegible]ur

S[illegible] LV[illegible]

THE TREATISE

OF

THEOPHILUS,

CALLED ALSO

RUGERUS,

UPON VARIOUS ARTS,

Is dedicated, by permission, to His Royal Highness Prince Albert and Her Majesty's Commissioners on the Fine Arts,

By their

Most obedient, humble servant,

THE TRANSLATOR.

PREFACE.

THE contentions, which during the third and fourth centuries agitated Eastern Europe, and in which Christianity was opposed to the fading doctrines and practices of Pantheism, awoke, amongst the supporters of either persuasion, a spirit of research, which was not pursued without great advantage to the practice of the arts, as it unlocked the hitherto closed gates of the mystic sciences, which had been the peculiar province of the priests, whether of Greece or Egypt, the only persons initiated into the "sacred arts," or "divine sciences."

The Christian emperors of Byzantium, who had succeeded their more warlike predecessors of Rome, were themselves participators in this war of persuasion; the sword had been laid aside, the toga donned, and the pagans were to be attacked by means of the strife of philosophy, so acceptable to the intelligence of Greece and Rome, enlightened at the same time by the spiritualism of Christianity. In the ardour of the conflict which the last of the pagan philosophers were sustaining against their irresistible opponents, means of defence were sought, not only among the received precepts of their own sages, but the mysticism of Egypt was introduced into Rome[1], and in her ancient hier-

[1] Jamblicus, a strenuous advocate of paganism, was initiated into the mysteries of the Egyptian Isis in the temple in Rome.

archical doctrines the weapons were solicited wherewith to foil their adversaries.

Nor were the theologians of this period averse to draw from the ancient philosophy itself, instances by which they might turn these weapons back upon the "Gentiles;" confident of their strength, and of the inequality of the combat, they met these upon their own ground. Apollonius, Solon, Thucydides, Plutarch, Plato, Aristotle, Sophocles, and the Sibyls[1] were summoned, to the delight of the Greeks, to aid in the overthrow of the antagonists of Christianity, and, having been honoured as bearing testimony in the conflict, appear to have remained to this hour, celebrated in the Christian iconography of the Greek Church, collaterally with the prophets of Judea[2].

The symbolism of Egypt appears to have exerted no small influence upon the arts during the early period of their introduction into Constantinople. Clement of Alexandria speaks of the tradition of a race of giants having been produced from the commerce of the angels with mortals[3]. Scaliger, citing a manuscript of Zozimus, adds that the book from which they taught their arts was called "CHEMA," Χῆμα, from this the word χημεία, chemia, was derived[4]. The sacred art, τέχνη ἱερα," was in the fourth and fifth century called chemia by the Greeks, and the instruments necessary for the

[1] Lactantius, "Divinarum Institutionum adversus Gentes."

[2] Manuel d'Iconographie Chrétienne, Grecque et Latine. Didron and Durand. Paris, 1845. A manuscript from Mount Athos. Ἑρμηνία τῆς ζωγραφικῆς. Pp. 140 and 148.

[3] Clement Alex. *Stromat.* L. V.

[4] Ola. Borrichii de ortu et progressu Chemiæ, in Bib. Manget. T. 1. p. 2.

practice of the science *χυικὰ ὄργανα*[1]. These philosophers, or chemists, of the Alexandrian, or the neo-Platonic school, have not been sufficiently remarked by writers on the progress of the sciences. Ammonius, of the second, Plotinus and Jamblicus, of the third, Zozimus, the Panopolitan, the describer of the distilling apparatus, of the fourth, Marie, the Jewess, Synesius, Olympiodorus, of Alexandria, Marcus Græcus, the author of the "Book of Fire," who is the inventor of Greek fire, which appears to be no other substance than our gunpowder, and who appears to have lived under Constantine Porphyrogenetes[2]: these have been almost neglected. The influence of symbolic mysticism, added to the alliance of ancient mythological representation, with the new portraiture, required by the Greek and Roman people in the illustration of their Christian temples, became at last so much abused, that the church was forced to interfere, and at the quinisext council, held at Constantinople in 692, this spirit of allegory was damped, although not subdued.

Under the reigns of Arcadius and Honorius, and even of Theodosius, the Christian temples were deco-

[1] Alexander of Aphrosidia. The word is probably derived from *χυμάω*, from the ancient word *χύω*, to pour or melt.

[2] A Latin translation of the Greek MS. is contained in the valuable MS. Sloane, 1754, written in the fourteenth century. Marcus Græcus is cited by Mesne, the Arab, who lived in the eleventh century. I translate the passage for the curious.—Fol. 232. "Flying fire is made in this manner: Take 1 scruple of saltpetre, 5 drachms of charcoal of the willow, or lime tree, and 3 drachms of sublimed sulphur (*sulphuris vivi*), and make a fine powder. And from this powder you can make an explosive fire (*ignem discrepantem*), and one flying in the air like a dragon."

rated with a magnificence capable of causing the converted Gentiles to forget those which were formerly the abode of their idols; the churches were already entirely covered with paintings or mosaic work; "on whatever side the eyes of the faithful were turned, the fathers of the church desired that they should be affected by pious representation and the mysterious effects of light."[1] The stories of the Old and New Testaments, the deaths of martyrs, the portraits of Apostles, were represented, sometimes landscapes, sea views, animals, &c., whether as allegories, or in order to impress an admiration of the marvels of creation. "Large draperies, sometimes ornamented with figures, floated before the doors, around the sanctuary, above the altar[2]; windows of stained glass contributed, by the effects produced upon the gildings and various precious ornaments, to increase the splendour of the decoration."

The Greeks were thus taught to prefer riches to the perfection exacted by their forefathers; the artist yet enjoyed some privileges, but the same laws which gave them confounded him with the gilder, the stucco layer, the plumber[3], and other workmen employed in the construction of the edifices[3].

The inundation of the Goths, under Alaric, consummated the work of havoc which the iconoclasts had, by

[1] Emeric David, *Discours historiques sur la Peinture*, p. 74. Gori *Vet. Dipt.* V. 3, Tab. 31, p. 261.

[2] St. Chrysostome remarked that all admiration was, in his day, reserved for the goldsmiths and weavers. In Joan. Homil. 69, C. 3. V. 8.

[3] Emeric David. P. 85. L. 2 and L. 4. *Cod. Theod.* De Exc. Art. Lib. 13. tit. 4.

the destruction of the ancient statues, commenced, barbarians as they were they appear to have advanced upon the ruins of previous destruction. The arts under Theodoric appear to have somewhat regenerated in Italy, under the fostering protection of that prince[1], while Justinian, at Constantinople, re-embellished the church of Saint Sophia with increased yet heavy magnificence.

The persecution of the artists by the iconoclasts under Leo, the Isaurian, A.D. 726, and which lasted 120 years, and the cruelties inflicted upon them, while it broke the chain which had for so long bound them, only excited them to new efforts. The more the artists were dragged to martyrdom by their oppressors, the more the class augmented. The woods and caves were filled with them. The dissemination of the arts was a natural consequence of such proscription: the popes of Rome opened vast monasteries for the reception of these artist monks who fled from Greece, which the benefits bestowed by Pepin increased. France, England, and Germany, were visited by them. Charlemagne ordained by a law (A.D. 807) that the ancient custom of decorating the whole interior of churches should be continued[2]; indeed the churches of Italy and

[1] Muratori, Script. rer. Ital. V. 2, part 1, pp. 113, 123.

[2] Capital. an. 807. cap. 7, apud Balur. Capit. Reg. Franc. V. 1, col. 460, quoted by David. "Volumus itaque ut Missi nostri per singulos pagos prævidere studeant . . . . . . primùm de ecclesiis, quomodo structæ aut destructæ sint, in tectis, in maceriis, sive in parietibus, sive in pavimentis, nec non in pictura, etiam in luminariis, sive officiis." Also Capitul. Karoli Magni et Ludov. Pii. Lib. 4. c. 35, and Lib. 5. c. 97. "Si vero essent ecclesiæ ad jus regium proprie pertinentes, laquearibus vel muralibus ordinandæ picturis, id à vicinis episcopis aut abbatibus curebatur," etc.

France were not considered finished until they had been thus decorated.

These works were all directed and executed by masters chosen in the Latin empire, within the seas[1]. Muratori has published a manuscript of this epoch, of Byzantine origin, which allows us a slight glimpse of the state of the studio at this period. See Muratori, Antiq. Ital. Medii Ævi. V. 2, p. 269.

In England the arts, which had been brought by the Romans into Britain, appear never to have been wholly neglected, although subjected to the vicissitudes consequent upon internal disorder and the irruptions of barbarians. "Even the Anglo-Saxons," writes Henry[2], "who were among the most destructive of the northern conquerors who overturned the Roman empire, did not long continue to despise the pleasing arts, particularly that of painting, which was practised by them with considerable success." We find that, previously to the edict by which Charlemagne resolved to encourage the various arts to the utmost of his power, Wilfred, Bishop of York, and Biscops, his friend, had already extensively availed themselves of the assistance of the artists, in order to decorate the cathedral of St. Peter, before the year 675. Biscops undertook a journey to the Roman states, and brought home many pictures with which the churches of St. Peter and Weremouth were ornamented[3]. The second visit of Alfred to Rome, with Ethelwolf, although undertaken at an early age, would

[1] "De omnibus cismarinis regionibus." *Monach. Sangall.* de eccles. cur. Karol. Mag. T. 3, C. 30, p. 118.

[2] Henry's History of England. Vol. 3.

[3] Bede. Hist. Abbat. Wiremuth., L. 1, p. 28 et seq. See also p. 434 of this work.

doubtless not be without due influence upon such a mind, when, upon his return, the society of Judith, his step-mother, the sister of Charles the Bald, contributed to unfold his character. The painted chamber at Westminster, in which Edward the Confessor died[1]; the renown of St. Dunstan as an accomplished painter and a skilful contriver of instruments[2]; the remains of the Saxon chased and enamelled work, which was esteemed upon the continent as early as the seventh century, and the manuscripts[3] which are yet extant, prove that, in this country at least, the arts, as introduced by the Romans, were never wholly lost; for, when Alfred the Great called workmen from all parts of Europe, in order to assist in the construction of the edifices he purposed to erect[4], it is probable that the first infusion of the Byzantine taste, which for so long continued amongst us, was imbibed: yet, previously to this period, the churches in England were hung with silk draperies, brought from foreign lands, while the windows and ceilings were richly decorated[5].

The Arabs, who at the commencement of the previous century had obtained an empire in Spain, were now (in the ninth) consolidating their conquests, and from the beginning of the tenth exercised an influence

[1] Smith's Topogr. of London, p. 12.

[2] Gervasius. Act. Pontif. Cantuar. in Hist. Angl. V. 1, 10. Also Strutt, pp. 5 et seq.

[3] One of these, illuminated, presented to Winchester Cathedral in 966, in which that monarch is represented adoring our Saviour, is in the British Museum.

[4] Asser. De Alfred. reb. gestis: *in Ang. Norman. à vet. script.* p. 13 et seq.

[5] William of Malmesbury. De gestis Pontif. Anglic. L. 3, p. 261.

upon the arts and the sciences. Gerbert, afterwards Pope Silvester II., was educated in the schools of the Arabs, in Spain, in the tenth century, and acquired their language. Less inventive than practical in science, the Arab writers appear to have accumulated the experience of preceding authors rather than made new discoveries, to have instructed rather than progressed. The simple character of the early sciences of the far east, with the speculative philosophy of the west, appear to have been united to afford them their knowledge. The Caliphs Harún-al-Rashíd and Al-Mamún were philosophers and scientific men; they caused the Greek classics to be translated into Arabic; from them the writings of the Arab physicians are principally drawn. The mystic doctrine of the neo-Platonic school of Alexandria, eminently qualified to captivate the ardent imagination of the Arabs, was adopted by them; they attributed to the science of alchemy the art of transmuting the metals into gold and the universal panacea[1]. Geber, their most famous chemist, who appears to have lived in the eighth century, as he is quoted by the Arab writers of the ninth, restored alchemical science to its true nature, and thereby earned the title of the father of chemistry. Geber has the credit of making known the process of distillation by a simple description, although this art had been for centuries described in the books of the initiated[2].

[1] Pocock. *Trans. of Albufarag. Hist. dynast.* Casirus. *Arabico-Hispana Escuri. Bibliotheca.* Leo. Libellus de viris quibusdam illustribus apud Arab. See for an account of the Arab chemists.

[2] A manuscript of Zozimus the Panopolitan (who lived in the fourth century), in the Royal Library at Paris, No. 2249, contains a description and a drawing of a distilling apparatus.

The ninth century, however, offers the important fact, in the history of the arts, of the invention or introduction of Painting upon Glass. The Benedictines have remarked upon this fact, and attribute the period, with every probability, to the reign of Charlemagne, who died in 814[1]. The art itself is probably of Byzantine origin, as the flux for colouring a plate or vessel of glass was known to the Greeks, who were much employed in the manufacture of the coloured and gilt glass mosaic work, as we shall presently see. A fact is mentioned in the chronicles of the historian of the monastery of St. Benignus, at Dijon, who wrote about the year 1052[2]. He states "that there existed *yet in his time* a very ancient glass window, in the church of the monastery, representing the martyrdom of St. Paschasie, and that this painting had been taken from the old church restored by Charles the Bald."[3] The reasoning appears inconclusive by which David seeks to limit the invention to the reign of this later monarch, as such poets, who have at all alluded to coloured glass as used in windows, have so cursorily noticed it, that it is sometimes even difficult to determine their meaning; the art was neither necessarily, nor would it be even probably, included in their descriptions, which relate to the effect produced by the light transmitted through the coloured medium[4].

[1] Histoire littéraire de la France, par les Benedictines de St. Maur. V. 6, p. 66.

[2] Chronic. *S. Benigni Divion*, apud D'Ach. *Spici*, V. 2, p. 383. Also Emeric David, p. 153.

[3] "Ut quædam VITREA ANTIQUITUS FACTA, et usque ad nostra perdurans tempora, eleganti præmonstrabat picturâ." *Loc. cit.*

[4] Prudentius. Anastas. in Honor. 1. *Ciampini, V.* 2. Sidonius Appolinarus. Fortunatus. Carm. L. 2. See notes to L. 2 of this work.

With the exception of the Arabs and the Byzantine Greeks, and a portion of the clergy, all Europe was, in the tenth century, plunged in a profound ignorance. Even the Emperors of the East were occupied in vain dogmatical controversy, or in repelling the attacks from without of Saracens, Sclavonians, or Bulgarians, while the rulers of the West, not more enlightened than their subjects, were almost powerless before the turbulence of vassals, whom the iron hand of Charlemagne no longer restrained. The clink of the mail, introduced by Charles, drowned the voice of science, and was only, but with difficulty, silenced, when opposed to its dogmas, by the jealousy of the Roman Church, now become a formidable power. Another cause of the general prostration of knowledge, during the tenth century, originated in the prevailing superstition that, at the end of a thousand years from the birth of Christ, the Antichrist would appear and the last days arrive[1].

When the opening of the new century had, however, somewhat calmed this disorder, and as the minds of men became reassured, the dark age seemed about to pass away, and a new zeal appeared to animate them. The ancient temples were everywhere, even without necessity, demolished; and in their places arose churches more vast and rich than the old, as if the world, again grown young, were being newly attired[2].

In the tenth century the monks of Richenaw ornamented many churches in Germany with paintings: Tutilo and the monks of St. Gall had erected and em-

[1] Robertson, *Introduction to the History of Charles V.*, V. 1, p. 45.

[2] Glabri Rudolph. Histor. sui temporis. L. 3, C. 4.

bellished the churches and monasteries in a surpassing manner[1].

It was apparently about this period (or the middle of the tenth century) that the compilation of ERACLIUS, "De Artibus Romanorum," was written; for it bears all the signs of this epoch. The bad Latinity in which it is composed, the complaints made by the author of the neglect into which the arts had fallen, sustain this supposition.

> "Jam decus ingenii quod plebs Romana probatur
> Decidit, ut periit sapientium cura senatum.
> Quis nunc has artes investigare valebit?
> Quas isti artifices immensa mente potentes
> Invenere sibi, potens est ostendere nobis."

That Eraclius, or Heraclius, was posterior to the seventh century, his quotation from Isidore, who died A.D. 636, attests. That he did not write later than the decline of the tenth, the absence of all allusion to the infusion of Arab science, which at the close of that century tinctured the arts of Europe, would denote.

The art of Eraclius is of the school of Pliny, increased, it is true, by Byzantine invention, but yet essentially Roman. Since Pliny had written, the art of glass manufacture and painting on glass and porcelain had made great progress, and the chapters of Eraclius upon this head are interesting; a few of these are quoted by Theophilus. The treatise of Eraclius likewise proves the existence of the art of mixing colours with oil and of the preparation of canvasses, skins, or panels, with colours ground in linseed oil, for the purpose of the reception of paintings which were

[1] Eckerhardi Carmina, T. 2, part 3.

afterwards to be executed in colours ground in the same oil[1].

[1] The most voluminous MS. of Eraclius at present known is contained in the collection of writers upon ancient art made by "Magister Johannes Le Begue, licentiatus in legibus, greffarius generalium magistrorum monetæ regis. Parisius, anno Domini 1431, ætatis verò suæ 63." This note is placed at the end of the MS., and is in the same handwriting as the rest of the book. It contains "Tabula de Vocabulis synonymis et æquivocis colorum, rerumque accidentium colorum:—Experimenta de Coloribus:—Experimenta diversa, aliaque de coloribus:—Receptæ extrahendæ ab uno quaterno michi presentato per fratrem Dionysium, &c., in Janua. 1409, scriptæ.—Item die Martis, xi. Februarii, 1410, feci copiari in Bononia a receptis mihi presentatis per Thedericum de Flandria, quas receptas idem Theodoricus dixit habuisse in LONDONIA in Anglia.—Item de diversis à quodam libello Magistri Johannis de Modena, pictoris habitantis in Bononia. (*Is this the painter John, born in Italy, who decorated the Abbey in the monastery of St. Gall, about* 990, *and who was afterwards called to Aix-la-Chapelle by Otho III. to enrich the oratory of the palace? Otho named this artist Bishop of Liege.* (*See David, p.* 156.) *This writer speaks of a mixture of oil and varnish, to be employed with colours.* "*Mordans quod stet ad ærem.*") Anno 1411. Johannes de .... Normannus, de azurro novo, lapidis lazulli ultramarini.—Liber Theophili, admirabilis et doctissimi magistri, de omni scientia picturæ artis (*a fragment, of the first book only, of Theophilus*). Liber magistri Petri de Sancto Audemaro, de coloribus faciendis:—Eraclii, sapientissimi viri. Libri tres de coloribus et artibus Romanorum:—Liber Johannis Archerius, A.D. 1398. Ut accessit a Jacobo Cona, Flamingo pictore:—Capitula de coloribus ad illuminandum libros ab eodem Archerio sive Alcherio, ut accepit ab Antonio de compendio illuminatore librorum in Parisiis et a Magistro Alberto Pozzotto perfectissimo in omnibus modis scribendi, Mediolani scholas tenente:—Aultres ecriptos en Latins en François per Magistrum Johannem Le Begue, &c., qui præsens opus seu capitula in hoc volumine aggregata propria manu scripsit, A.D. 1431. Ætatis verò suæ 63. Illustra Deus oculum." A copy of this manuscript, which I verified with the original in March 1846, was kindly presented to me by the Count

But a new impulse had been given to the arts at an early period of the eleventh century. Emulation was first directed to the sciences and literature, which at that period the services of the church and political quarrels rendered the most necessary, towards theology, jurisprudence, geometry, logic, rhetoric, music or psalmody, architecture, and painting. Dunstan, Aldred [1], and Lanfranc in England, Robert in France, Hildebrand at Rome, were encouraging the arts, raising and decorating churches, which the reverence for relics caused to be ornamented by sumptuous shrines and costly gates of bronze or silver [2]. In England, France, and Italy, a great number of manuscripts, ornamented with miniatures and otherwise illuminated, were executed [3]. The ornaments for the Roman altars, desks of gilt bronze, and objects which ornamented the choirs much favoured the arts of casting metals, modelling, enamelling, niello, damascene work, and often produced works of surpassing execution [4].

It is to this period, the early half of the eleventh century, that the work of Theophilus upon "THE DIVERS ARTS" is to be ascribed.

While Greece was the painter of the continent; Tuscany, the enameller; Arabia, the worker in metals;

de L'Escalopier. It will be seen that I have made considerable use of it in elucidation of the meaning of Theophilus.

[1] William of Malmesbury.

[2] Ciampini. *Vet. monum.* v. 1, c. 4.

[3] Montfaucon, *Diar. Ital.* p. 322.—Strutt, Antiquities; Ancient England.

[4] Vita B. Richardi, ab S. Viton. Virdun. c. 6. Acta SS. ord. S. Benedict, v. 8, p. 541.—Emeric David, p. 215.

Italy, the jeweller[1]; France, the worker in glass; Spain, the chemist; industrious Germany, anxious in acquiring dexterity, or knowledge in all: when all these artists had constructed and were adorning the church of St. Mark at Venice, and were elsewhere occupied in Western Europe in "writing" or painting the sacred histories in the churches (the terms were at that time synonymous), so that the illiterate might read the examples set before them[2], the "TREATISE UPON DIVERS ARTS" came forth.

It is, however, principally by analysis of the processes described by our author that we can be enabled to ascertain with some precision the epoch at which he wrote. Lessing, Leist, Raspe and Emeric David, have placed Theophilus in the tenth century, a period too early, as we may confidently infer, by remarking the occurrence in the work, not only of Arab mysticism, but of Arab nomenclature. The chapter of Theophilus on the production of "Spanish Gold," L. III. p. 267, is evidence of the former; his mention of Borax, p. 239, under the confused name of Barabas or Parahas, of the latter; while both instances shew, at the same time, a

[1] This was at a period before Italy had for a second time become glorious by means of art. This word "glorious," applied to Italy, is not found in any of the older MSS. of Theophilus, and is certainly an interpolation of Le Begue himself, in whose MS. only it is found, and who wrote at the commencement of the fifteenth century, when Italy had indeed acquired a claim to the title.

[2] The council of Arras in A.D. 1025, declared that "the books of the illiterate were the paintings in the temples." Illiterati, quod per scripturam non possunt intueri, hoc per quædam picturæ lineamenta contemplantur."—*Synod. Attrab. C. 3. T. 1. p. 62.* Apud D'Achery.

very early and incomplete knowledge of their works, which he had probably heard of in Constantinople or Italy[1].

Monsieur Guichard, Monsieur Didron, and the Abbé Texiér assuredly have assigned too late a period, when they fix the twelfth or thirteenth century as the epoch of Theophilus.

It is remarkable, and is a correlative proof with what has been remarked above, that there is no mention in the "Treatise upon Divers Arts" of distillation, nor is any substance indicated by which we can presume that Theophilus was acquainted with that art. This, coupled with the preceding facts, will place our author in a period of transition, or among the writers of the early part of the eleventh century. The school of medicine of Salerno had but commenced at that period to inculcate the Arab science, and to disseminate it through Italy. Had Theophilus been cotemporary with Roger Bacon or Raymond Lully, as Mr. Guichard supposes, this art, which would have simplified so many of his processes and which has added so many materials to art, would have been noticed. The influence of the crusades, although doubtless great upon the taste of Western Europe, we have already seen could have but little, if at all, added to the sciences. There is no art mentioned by Theophilus which was unknown at the commencement of the eleventh century; yet distillation, or any of its products, is omitted, although a glimmering of Arab science is observable in the work.

[1] "The works of the Arabs were known in Italy before they were known in France and the other countries of Europe." *Hoefer, Hist. de la Chimie,* p. 346.

Another circumstance may be adduced favourable to this opinion. The very few instances in which Theophilus affords iconographical description are eminently of this period of art. In the delineation of the beaten censer, L. III. C. 60, Byzantine art is particularly observable; the octangular towers, the long columns, the lengthened windows, the circular opening above the centre column between them[1]; the rivers of Paradise in human form, the raised arch at the bottom of the censer, in which are the figures of the evangelists, whether delineated in likeness of men or symbolically, are all of Byzantine art; but in C. 61, the marks of the period are yet stronger. The figures of the Jewish prophets fraternized with those of the apostles, with their names inscribed above the head, each provided with their testimonies "that they may agree with each other;"[2] the personification of the virtues, also with the name inscribed; the Arabesques; are not only Byzantine, but, if introduced into the West, indicate, according to M. Didron, an early period of the eleventh century. "The East, where the old law was born, always remained faithful to its respect for the Jewish law, and the personages of the Old Testament. With us, the characters of the Old Testament, however elevated in esteem and glory, are not equivalent to a saint,

[1] This description does not coincide with the character of ogival decoration of the thirteenth century, which M. Guichard and the Abbé Texier attribute to it.

[2] "The Greeks, more discoursive than the natives of the West, place inscriptions every where. This is a great advantage. Had our Gothic ancestors acted thus, we, archæologists, should have less trouble to specify, or name, personages and subjects sculptured or painted in our churches." Didron, *Manuel de l'Iconog. Chrét.* p. 464.

much less an apostle, prophecy is placed in the same rank as history; in Greece, they wear the nimbus and are holy, their feet are bare, and they are assimilated to the Apostles." "Until the eleventh century, Latin, as well as Greek Christianity, fraternized with the Jewish religion, but from the moment of the schism, consummated by Michael Cerularius, this respect sensibly diminished."[1]

The Roman Church, of which the head, Hildebrand, afterwards Gregory VII., had, in the middle of the eleventh century, matured the plan of an universal power, the more frightful because under the form of an universal theocracy, would not be likely to tolerate the progression and dissemination of a practice contrary to its dogmas; Dante did not appear until the fourteenth century.

M. Guichard remarks, with truth, that this treatise belongs to a period of transition—"de renouvellement et de renaissance." This character is pre-eminently attached, as I have endeavoured to show, to the early half of the eleventh century.

Who, and of what country, was this artist Monk? is a question which must still remain a problem. Lessing, misled by a resemblance of names, was inclined to attribute the authorship of the "Diversarum Artium Schedula" to Tutilo, the Monk of St. Gall, who lived at the close of the ninth century[2]. Lessing has not been able to seize from the text of Theophilus a single indication which militates in favour of this high antiquity of the book, and his argument reduces itself to an analogy of proper names, this name also being very

[1] Didron, *Manuel de l'Iconog. Chrét.*, pp. 133, 134, 135.

[2] Vom Alter der Oelmahlerey, pp. 304, 323, 362, 363.—*Raspe.*

common. It is not sufficient, observes M. Guichard, that, as a Tutilo is found in an old chronicle qualified as "painter," *picturæ artifex*, he should have written the "Diversarum Artium Schedula."

It is a circumstance not to be neglected, that all the manuscripts of Theophilus, at all copious, have issued from Germany. Matthias Farinator, the editor of the Lumen Animæ[1], and who first has mentioned the work, relates that he received it from a monastery in Germany. The Lumen Animæ, however, contains, with citations from Theophilus, allusions to sentences which are not to be found in the chapters of our author, and which are probably part of an appendix, or addition, made by the scribe or possessor of the volume, and which Farinator had not the acumen to distinguish.

Of the different manuscripts of Theophilus which have been yet remarked, that mentioned by Farinator claims the first notice. The fate of this MS. is unknown; it is probably in the Vatican, buried in the mass of unknown works which have yet to be described.

The manuscript alluded to by Cornelius Agrippa[2] is now at Wolfenbüttel, according to Raspe, who, however, gives no authority for this statement. The MS. which exists at Wolfenbüttel is thought by Lessing to be of the tenth or eleventh century. The third book of this MS. terminates with the first chapter upon the organ, as I have noted in the work, p. 345.

The manuscript at Leipsic, which had been forwarded to Lessing at Wolfenbüttel, is thought by him to be of the fourteenth century[3]. It likewise contains three

[1] First printed A. D. 1477.

[2] "De Vanitate Scientiarum." C. 96.

[3] Vom alter del Oelmahlerey, p. 21, 85.—*Raspe.*

books, but the third has been mutilated; it possesses the first seven chapters only of the book. This MS. came from the convent of Alten-Zell[1].

A MS. in the public library of the Cambridge University, was discovered by Raspe in 1779, and stated by him to be in the writing of the thirteenth century. This merely contains a portion of the first book of Theophilus, with an appendix by the copyist collected from other writers. A copy of this MS. is in the British Museum. Sloane, 715. Raspe states that this MS. is in 4to, and in the handwriting of the thirteenth century.

Another copy was found by Raspe in the Trinity College library, and is also in the writing of the thirteenth century. This MS. is now in the British Museum. It is that published by Raspe; it contains a portion of the first book of Theophilus, with a collection of recipes at the end, among which are to be found the five chapters given by the Count de L'Escalopier[2]. which are not by Theophilus. These are neither to be found in the Harleian, the Vienna, nor the Wolfenbüttel MSS. It is in this manuscript that the epithet "Lombard" is given to the first book, "*Sic incipit Tractatus Lombardicus Qualiter temperantur Colores ad depingendum.* Whether the books of Theophilus are "Lombardic" or not, it is an instance of the estimation of the writer in the thirteenth century. Lombardy was the pupil of Byzantium, and this is corroborative of the view I have taken throughout my notes to this work, that the influence of the Byzantine Greeks is every where traceable.

[1] Simler, "*appendicem Bibliothecæ Conr. Gesneri.*"—Tiguri, 1555.

[2] C. C. xxxiii—xxxvii. L. 1. Edit. Paris. 1843.

Another MS. of the seventeenth century was announced by Morelli in the Nani Library at Venice, in which Theophilus is called RUGERUS. Morelli states that this is copied from the ancient parchment Codex in the Imperial Library at Vienna: "*descripti ex antiquo codice membranaceo manuscripto Augustissimæ Bibliothecæ Cæsareæ Vindobonensis.*" M. Guichard has omitted this conclusion to his quotation from Morelli, and questions the correctness of the statement made in p. 35 (*Morelli, Cod. manuscript. Lat. Biblioth. Nani.*) that there were two manuscripts of Theophilus at Vienna.

Mrs. Merrifield[1] writes to me that she saw a copy of Theophilus at Milan, made from the old Vienna Manuscript, similar to that in the library of St. Mark at Venice.

The copy contained by the Le Begue MS. in the Royal Library at Paris has already been noticed. It is a very careless transcription of the first twenty-nine chapters of the First Book only, and in quantity is similar to the Trinity College MS. published by Raspe, but the appendix is wanting.

Although neither Lambecius nor other bibliographers have noticed the Manuscripts at Vienna, and, in consequence, M. Guichard suspects some error in the statement of Morelli already referred to, I have been able to ascertain, through the kindness of Dr. Ferdinand Wolf, of the Imperial Library, that the assertion of Morelli is correct.

Extract of a letter, dated "Vienna, 18th June, 1846.

"The dates which Morelli gives are exact; we possess two manuscripts, of which one upon vellum (now

[1] The accomplished translator of Cennino Cennini.

No. 2527), belongs to the twelfth, or, at latest, to the very commencement of the thirteenth century; the other (No. 11236) is but a copy, but made from another manuscript than our own; it is of the seventeenth century, and is upon paper."

"The ancient manuscript is defective: it commences by the three prologues of the three books, the index of chapters of the first book follows. The rubric of the first chapter stands, *De temperamento colorum in nudis corporibus*, the last, the thirty-eighth, *Quomodo colores in libris temperentur*. The second book contains thirty-five chapters, of which the title of the first is, *De constructione furni ad operandum vitrum*; the last, *De anulis*. The third book contains seventy-eight chapters; the first, *De constructione fabricæ*, the last, *De organis*; but, as I have said, some leaves are wanting at the end."

"The other MS., the modern copy, gives also the prologue of each book, and then the index; the first book contains forty-two chapters, viz., *De temperamento colorum*, *&c.*, the last, *De cerosa*. The second book is composed of thirty-five chapters, conformable in every thing to the other MS.; and the third book contains seventy-six chapters, viz., *De constructione fabricæ*; the last, *De organis*, and finishes '*a plectro autem inferius omnes unius mensuræ et ejusdem grossitudinis erunt. Finis.*'"

It will be seen that the more modern manuscript is similar to that at Wolfenbüttel, which is deficient in the C. xl. L. 1. *De encausto*, contained by the Harleian and the Cambridge University MSS.

Dr. Wolf thus replies to my demand respecting the four missing chapters in the second book, which yet form a part of the index.

"Vienna, 5th Sept. 1846.

"The chapters which are wanting in your manuscript, and of which you have requested a copy, are equally absent from both our manuscripts, although they figure in the index; in this respect, therefore, our MSS. are exactly conformable to the printed text."—*(The Edition of Leiste and Lessing.)*

"I have the pleasure of remitting you the fac-simile of the first page of our most ancient manuscript, (of the twelfth century,) which you likewise requested, and which, at my request, my colleague, M. Ernest Birk, proficient in this art, has had the kindness to transcribe."

This fac-simile I have caused to be placed at the commencement of the work, as it belongs apparently to the most ancient copy of Theophilus known, one of the twelfth century, and it bears the name of RUGERUS.

For how can we reconcile the conflicting opinions of Lessing and Leiste? Lessing affirms the Wolfenbüttel MS. to be of the eleventh, Leiste, of the tenth century; both Lessing and Leiste assign the thirteenth or fourteenth century as the date of the Leipsic manuscript; Leiste himself was undecided, as the following passage will prove. Comparing the manuscripts of Wolfenbüttel and Leipsic, he writes, "*Beyde sind in gross Quart auf Pergamen geschrieben, und gleichen sich sehr in den Schriftzügen, so dass man sie wahrscheinlich in ein Jahrhundert versetzen muss.*"[1]

Paleographical knowledge has much increased since

[1] Zur Geschichte und Litteratur. T. 6. Vorbericht. p. 5.

"Both are written in large quarto on parchment, and resemble each other much in the written character; it appears, therefore, that they must be placed in one and the same century."

that time, but in the absence of proof it may be conjectured that they are both of the thirteenth century, a period at which the work of Theophilus was multiplied.

I have therefore adopted the title of the manuscript of Vienna as probably the most correct, for the title and prologue of the first book are unfortunately wanting in the Harleian Manuscript, otherwise so complete. RUGERUS was probably the name of the Monk; Theophilus, one of those names often assumed by the priests according to the bent of their ideas. It is a title above all others likely to have been adopted by our lowly priest and monk, who regarded his own labour and study, and that of others, "as so many sacrifices offered up to God." The Abbé Texiér eloquently writes, "Théophile est un nom de guerre, un nom de religion. L'humble moine, qui s'oublia si complètement en un traité qui pouvait donner la gloire, dont le travail artistique n'était qu'une prière, l'humble prêtre, qui se regardait comme indigne du nom et de la profession monastique, a caché sa personnalité sous une appellation allégorique; il se nomme THÉOPHILE, comme l'âme dévote de Saint François de Salles s'appelle PHILOTHEE."[1]

Lombardy, which was overrun and peopled by the Germanic tribes at an early period of Northern irruption, was possibly the country of our author. Theophilus may have written for the Germans, although himself a foreigner: in such case the German words found in his

[1] *Analyse du Traité de Théophile, par* M. l'Abbé Texiér, *Annales Archéologiques. Didron ainé, Paris. March,* 1846.

books, so much insisted on as proof of his Germanic origin, would be employed as explanatory, not used idiomatically. Both Greek and Italian terms are likewise employed, as "asperella," "smigma," "ismaris," "isca," &c., &c.

The most important, because the most voluminous and correct, if not the most ancient, manuscript, now remains to be noticed, and which I was fortunate enough to discover among the Harleian Manuscripts at the British Museum. Owing to the imperfect classification of these MSS. towards the end of the last century, this had remained unknown or unnoticed until I had withdrawn it from its hiding-place; classed in the general catalogue immediately under the head of THEOLOGY, and after "Theophilus" the ecclesiastic, is found "Theophilus, monachus;" it has doubtless, therefore, been classed with works on theology. It is not mentioned under the works treating upon the arts, but under the head "Natural Philosophy," "Physics," is found "Theophilus Monachus, de Chemia," a position in which we should never have expected to find our author upon "The Divers Arts," and which sufficiently accounts for its neglect[1].

This manuscript is upon vellum, in octavo, and is written in a clear German character of the very commencement of the thirteenth century. Sir F. Madden, the keeper of the manuscripts at the British Museum,

[1] Sir Frederick Madden assures me that, although he was aware of the existence of such a manuscript, he was unacquainted with its true importance and value, until it had been called for by me in January, 1844, and he had collated it with the Paris edition, printed in 1843, by the Count Charles de l'Escalopier.

and whose authority is conclusive, states that it is of that period, and that it is certainly written in Germany [1]. It contains 115 folios of the books of Theophilus, and five folios of recipes relating to the arts, written by another hand of the period. A treatise "De Unguentis" follows; it is a collection of medical recipes. The title and preface to the first book are unfortunately wanting; in so voluminous and superior a copy something might have been otherwise adduced from these which would have unravelled the mystery which shrouds the age and country of our author.

That this MS. is likewise but a copy from an older work is proved by the variations it presents from the Vienna and Wolfenbüttel MSS., supplying many omissions, claiming also the restoration of a few which I have carefully noted during the progress of the work. The four chapters missing in the second book (see Index, p. 110), have probably been cut from the original, as no lacuna is left by the scribe in this.

It will be observed upon perusal that the whole of the work, from C. LXXXI. L. III. p. 345, is new. It had been hitherto lost; the promises held out in the preface to the First Book are fulfilled.

The Third Book has evidently been treated by Theophilus with more care and attachment than the others. The eloquent preface, the labour expended in description, and the great volume of the work upon metals, attest this. He had proceeded gradually to describe "all those things which were still wanting among the utensils of the House of the Lord," [2] when

[1] Sir Frederick stated to me that it was not impossible that this MS. was written at the end of the twelfth century.

[2] Preface to L. iii.

the treatise abruptly closed with one chapter on the construction of the organ. The description of this instrument is now rendered complete[1] as it existed in the time of our author. An important description of the manner of founding bells follows. The next, "Of Musical Cymbals," tends to show the antiquity of the author. Our monk treats of the more humble vessels, made of tin; of iron, with a description of the apparatus employed in Damascus work upon steel. Then follows a description of the Italian work promised in the preface to the whole work, of sculpturing, gilding and staining ivory; of gems, pearls and electra. It should be remarked here that Theophilus quotes Eraclius, a strong argument against his Italian origin. The monk would here appear to have travelled, note-book in hand, to collect the various arts from different countries. The passage in the preface to the Second Book, which I have preferred to translate literally, rather than to take in the allegorical sense, in which it has been hitherto received, and which the character and writings of Theophilus do not warrant, affords strong presumption that Theophilus was no Greek monk, which his description of the "fistula," the reed or pipe formerly used by the Roman Church in the celebration of the sacrament, confirms: "*apprehendi atrium Agiæ,*" or "*Regiæ Sophiæ, conspicorque cellulam diversorum colorum omnimoda varietate refertam et monstrantem singulorum utilitatem ac naturam. Quo mox inobservato pede ingressus, replevi armariolum cordis mei sufficienter ex omnibus, &c.*"[2] The phrase "*inobservato pede,*" points

[1] Note, p. 439.

[2] See p. 117. The Atrium was at all times open to the public

to the existence of schism between the two churches, which strengthens our view of the period of our author: and this literal acceptation is warranted by the description given of his efforts and travels, to procure information, in the prologue to L. I. "*Quapropter, fili dulcissime, quem Deus omnino beatum fecit in hac parte, qua tibi gratis offeruntur, quæ multi, marinos secantes fluctus cum summo periculo vitæ, famis ac frigoris artati necessitate, &c. &c.*" The book concludes with two chapters, certainly by Theophilus, "of fish glue," or isinglass, and "of signs, when searching for water."

Although the whole work of Theophilus abounds with curious and valuable information, yet the allusion to the practice of painting with colours ground in oil has perhaps elicited more attention and remark than any other part of the treatise, on account of the generally received opinion, drawn from the statement of Vasari [1], which has been followed without further inquiry by the Italian writers, and adopted by C. Van Mander [2], that painting in oil had been the discovery of the brothers John and Hubert Van Eyck, in 1410.

This statement has been so completely refuted that further labour is needless on this point. Horace Walpole, the Rev. Mr. Bentham, and Mr. Smith, have shown that the art of painting in oil was practised in our own country from an early period up to the fifteenth

indiscriminately; the side colonnades and porticus afforded shelter to the catechumens and penitents, aud such others as were not allowed to advance beyond the threshold of the church itself. The Atrium was also often used as a place of burial for persons of high distinction. *Description of the Basilica of St. Clemente, by R. W. Mylne, Esq.* Weale's Quarterly Papers, 1845.

[1] Vite de' più eccellenti Pittori. Mil., V. 5, p. 97.

[2] Het Schilder-Boeck. Amst. 1617, fol. 123.

century[1]. Raspe has sufficiently and successfully opposed the assertion of Vasari; and the mention, by Vasari himself, of the picture in oil, painted by Lippo Dalmasio, at Bologna, in 1407, is sufficient confutation of the tale. The passages from Eraclius and Cennino, which I have given in the above-named notes, are sufficient to prove that the art of using driers with oil in the process of painting, so as to render the work less tedious, was likewise known previously to the time of Van Eyck; the opinion of Raspe[2], in which M. Guichard coincides, is not therefore tenable.

A third supposition was started by Emeric David[3], that painting in oil, having been abandoned in the tenth or eleventh century, had been invented anew in the fifteenth by John Van Eyck. This is open to equal objection, as the English authors referred to above have shown; and it is singular that some of the materials used for the purpose of painting the chapel of St. Stephen, in 1350, were procured from Bruges: "the sum of four shillings and ten pence was paid to 'Lomyn de Bruges' for six pounds and a half of white varnish, at nine pence per pound."

Yet that Van Eyck merely pursued the path which had been previously trodden, no one can admit who has compared his works even with those of modern times, which we know to have been painted with oil simply, (the more ancient works having disappeared partly on that account, and partly from the class of colours in use, as will be seen by a reference to notes

[1] See note on "Gummi Fornis," p. 71 of this work. Also note on "Oleum Lini," p. 94, id.

[2] "On the discovery of Oil Painting," pp. 6 to 19, and 54 to 71.

[3] "Discours Historiques sur la Peinture Moderne," p. 188.

to L. I.); and that he was the inventor of a means of rendering his pictures bright and permanent, we have at this hour the evidence of his works to show. The freshness and purity of his colours, and the transparent medium, which allowed every means of careful execution, are not to be obtained by the linseed oil varnish described by our author, and in use in Italy and Germany, on the authority of Cennino, previously to his time.

Having been too much lauded, the Van Eycks have lately risked the being too much decried: improvement in every art is, in something, debtor to the pre-existing state of that art, and our inquiries upon these being likewise naturally progressive, in seeking the cause of the reputation of Van Eyck, we may again, by striving to promote the truth, discover the secret of his success.

Paul Lomazzo, an author of credit, has the following singular passage in his "Arte della Pittura." Writing of Leonardo da Vinci, he says[1] "*Leonardo ha colorito quasi tutte l'opere sue ad oglio, la qual maniera di colorire fu ritrovata prima da Gio. da Bruggia, essendo certa cosa che gli antichi non la connobbero.*" Thus far Lomazzo follows Vasari: he continues, "*Ora Leonardo fu quello che lasciato l'uso della tempera passó all' oglio, il quale usava di assotigliar con i lambicchi.*" He adds to this that, on account of the bad priming upon the walls, the "Wonderful Battle Piece" at Florence, and the "Last Supper" at Milan, were spoiled.

Upon turning to the works of Leonardo da Vinci, we find that the materials mentioned by that artist are either walnut oil, thickened in the sun, or amber varnish and walnut oil[2].

[1] Gio. Paolo Lomazzo, Pittore. *Arte della Pittura.* Bologna, 1590, C. xiii.

[2] Trattato della Pittura di Leonardo Da Vinci, C. ccclii.

Having shown, in a note to L. I. p. 63, of what the varnish of Theophilus was composed, and which was employed during the early period of art, there is every reason to believe that "AMBER VARNISH" was one of the inventions of the brothers Van Eyck; and that this invention was carried into the school of Venice we have proof[1]. The head of a Venetian Doge, by John Bellini, in the National Gallery, is painted with this varnish. Mr. Eastlake pointed out to me the amber beads hanging upon the wall, in the picture by Van Eyck, in the same place: this is a curious circumstance worth notice.

In the manuscript, Sloane 345, Pl. 85 C., which contains a series of medical writings, "Tract. Var. Medicinal." collected by Johannes Ketham, who flourished towards the latter part of the fifteenth century, is a book upon colours and materials for painting, written in old Dutch or Flemish, and which should therefore be of an earlier period in the same century. In this I found the first mention of amber varnish yet upon record, and it arrives from the country of Van Eyck. The MS. is extremely difficult to read.

"*Substancie tmaken daer alle Wnē indinz.*

"℞ 1 ℔ *lyn olys end sidz een ure end dan nemt* viii. *loet bernsteen ghepulvirt end doen dy yn een erden poot ende ghiten dar op lyn oly dy voer gesad is dat dy wynsteȳ bedowē ys myt den oly end laten dat syden also langhe dat de bernsteen gesmont̄ ys dy bernsteen soe salmet̄ sy ghen doer een doeck eñ doent tostē irst̄ oly*

[1] I shall have better opportunity and more space to treat upon this in a work, preparing, to which I have before alluded. MR. EASTLAKE, whose work, "CONTRIBUTIONS TO THE LITERATURE OF ART," we are expecting, possesses further documents, and will enter upon this subjeet.

end latet̄ sid̄ pruvet op eȳ leye of het sterck genoch sy. End yst steerck genoch soe doet dar 1 *pont spigelhars yn end latent syd̄ een luttel end dan so settet af̄ end dan ys bereyt.*"[1]

In the accounts handed down to us, Van Eyck is described as a clever chemist, and it is stated that he was continually consulting works upon that science for information. The works of the Arab chemists had become known; Albertus Magnus, Roger Bacon, Arnold of Villa Nova, Raymond Lully, had all lived and written upon the "Magnum Opus," the basis of which rested upon sublimation and distillation, by means of which the elixir, spirit, or excellence of all things were to be extracted. The words of Lomazzo, which we have quoted above, would therefore probably bear a literal meaning.

Leonardo da Vinci is stated to have followed the manner of colouring invented by John of Bruges, and to have thinned his oil by means of alembics. This, I was convinced, intended, that Leonardo distilled the oil (he himself mentions walnut oil) for the purpose of painting.

Aware that the older Italian writers used the word "*lambicco*" as representing any chemical apparatus, yet

[1] The materials employed are 1 ℔ linseed oil, *lyn olys;* 4 ounces of amber in powder, *bernsteen ghepulvirt;* (a loet is half an ounce,) and 1 pound ~~litharge~~, *spigelhars.* The amber is dissolved with a little oil over the fire; when dissolved, the oil is added hot by degrees; the ~~litharge~~, of which an enormous quantity is added, is then put in; it is cooked a little, and is finished. There were various modes of making this varnish practised in Italy at a later period. The process here described would make a very dark varnish, which would require to be thinned with walnut or other oil for use.

having always found that by *stillare* or *assotigliare per lambicco* distillation was intended, while filtration was described as *distillare per feltro*, it became necessary to seek for any precedent that distilled linseed, or walnut oil, was used in the art of painting, experimenting, at the same time, at home. I was fortunate enough to succeed in both instances[1].

[1] I think it better to give the result of the experiment as I noted it down at the time it was tried, without further comment than that it is one which should be attempted by no inexperienced hands; the explosive nature of the gas produced rendering the process highly dangerous to an unskilful person, although a very simple and easy one to the chemist, or other operator.

Walnut Oil: its Distllation.—March, 1845, and July 25, 1845.

. 4 oz. distilled in a glass retort and receiver, over a small charcoal fire without flame.

Water was the first product; then came over a light-coloured empyreumatic oil, which gradually became of a darker colour, mixed with water during the whole process of distillation.

The ebullition in the retort was at first great, but it gradually lessened as the oil became of greater substance. The heat is required to be increased to keep up the vapour producing the distilled oil. As the process continued, this vapour became more abundant, and a quantity of gas was liberated, to allow of the escape of which the stopper in the receiver must be greased and loosely dropped into its place; care should be taken to visit this often, in order to guard against explosion. It appears to me during this process that oil will not spontaneously take fire at a great heat; it requires contact with flame or a red heat in order to do so.

Carbonic acid and carburetted hydrogen gas are the principal gases produced. This mixture of gases, probably owing to the great excess of carburetted hydrogen, is highly inflammable: it is the production of this, not of a highly inflammable volatile oil, which causes oil, raised to a very high temperature, to take fire when in contact with flame, or highly heated bodies, such as red-hot iron, &c,

Volatile oils of two specific gravities were produced; the first (before an increased temperature was given to the retort) was of a

The earliest mention I find of distilled linseed oil is in conjunction with amber varnish; it is to be used as a varnish, or glaze, upon painted subjects, and it is contained in a collection of recipes relative to the Arts,

less specific gravity, and also of a lighter colour than that which follows, and it forms a stratum upon the darker and denser volatile oil. The darker volatile oil is of the colour of pale amber, the lighter a very pale straw colour, almost colourless. They unite by agitation, as also will the small quantity of water, if the oil is not carefully decanted from it.

MEMORANDUM, October 28, 1845.

This distilled or empyreumatic oil should be kept in a jar covered with muslin so as merely to keep out dust and dirt, but to allow the entrance of air and the escape of the empyreuma. In a short time this oil, which is at first so pungent and offensive, becomes gradually of less powerful odour, and in a few weeks is not of more unpleasant smell than boiled linseed oil. It appears to absorb oxygen by contact with air, and at a temperature of 40°, F. becomes flocculent in appearance, while at 70°, F. it remains transparent. This is not a deposition of stearine, but the effect of a diminution of temperature, the absence of heat causing it to become solid, as is the case with many distilled oils, at that temperature.

Amber varnish, (and probably other thick oil varnishes,) would be equally benefited thinned with this distilled oil; it dries without a pellicle when mixed with colours. Colours used for finishing a picture, such as in the light for solid painting, or glazing for colour and shadows, are rendered very pure, and without the slightest appearance of a skin, although it may be plentifully used. It dries much more slowly than any other distilled oil, and hence its great value, as it allows the artist as much time as he requires in order to blend his colours and finish his work. In conjunction with amber varnish it forms a vehicle which leaves nothing to be desired, and which doubtless was the vehicle of Van Eyck, and in many instances of the Venetian masters, and of Correggio, the different modes of painting necessarily producing the varied appearances of the different schools and masters.

made by a monk of the order of Jesus, contained in the Lucca Ed. 1577[1].

"*A far un liquore et vi usa da dove p. vernice sopra le figure. Piglia olio di seme di lino, fatto distillare a lambico di vetro, poi piglia vernice d'ambra, che sia bella, oncie 3, et dell' d'to oglio oncia 1, e incorporali bene insieme con lento fuoco poi adoperarlo calo a modo di vernice, et si riusceva bene in legno, in tela, in guazzo, e in ogni opera e lavora con destrempa.*"

In Chapter XV. L. 2, is the recipe for the manufacture of the Greek glass which forms the ground of the Mosaic pictures in St. Marc's church at Venice, and which were commenced at a period subsequent to the labours of Theophilus, by Doge Dominico Silvio in 1071; these were all executed by Greek artists. St. Sophia was covered with this kind of rich decoration, called ψήφωσις by the Greeks[2].

[1] "Secreti di Don Alessio Reverendiss°. Piemontese, con una bellissima aggiunta de secreti da uno reverendo Padre Jesuato, pratica et eccellenta." 4to. *Lucca.* 1557. Wecker, "*de secretis,*" *Basle,* publishes this as from Alexius, p. 643. "Ad picturas illustrandas. Rec. olei lini quantum volueris, destilletur in cucurbita vitrea donec omne exierit oleum, de quo sumito unc. j. Vernicis ambræ unc. iij. misceantur ad ignem lentum probè, et fiat mistura, qua calida utere ad omnis generis picturas, sive in ligno, sive in tela fuerint. Verùm industria, ac dexteritate opus est utendo."

[2] This word "*fsefōsis,*" which signifies an arrangement of small stones, is called "*fsefysa,*" by the Arabs, from the Greek word, which is the appellation they give to Mosaic work, the "Lithostratum" of St. Isidore of Seville. From the chronicle of the patriarch Eutichius, it appears that when the Mussulmans invaded Palestine, for the first time, they found the church of Bethlehem, built by St. Helena, ornamented with fsefōsis. According to Ebn-

But "de pictura satis superque," and my labours are drawing to a close. In my notes I have offered such explanations of the terms used by Theophilus as the limits afforded me will allow; I hope that the reader will not find them misplaced.

An increasing taste is obtaining for the beautiful and spirited works of art belonging to the middle ages, for things which the last century abandoned to contempt and neglect: the important works which have lately been undertaken in this country, and which are probably destined to increase, render an apology for the introduction of this book needless; information upon these subjects is every where sought, and an opportunity is afforded for the instruction of the artist and artizan, as much needed in our time as in that of our author. The prospect of the general diffusion and employment of art in our English Protestant cathedrals

Sayd, one of the conditions of the peace, concluded at the commencement of the eighth century between the Caliph Valid and the Greek Emperor, was, that the latter should furnish a certain quantity of "fsefysa" for the decoration of the Mosque of Damascus, which the caliph was then constructing. (*Notice upon the Works of M. de Prangey, Journal Asiatique, An.* 1842, *p.* 9, 10.) The same word, "ψῆφοι," is found in the Athos MS. (loc. cit.) to designate mosaics. "But," writes M. Didron, "these are mosaics in glass, transparent, with golden grounds, as the words 'ψῆφοις χρυσέοις' indicate: these are the mosaics which cover the vaults, cupolas, and a part of the walls of St. Sophia of Constantinople, of St. Sophia of Salonica, of Vatopedi and of St. Laura of Mount Athos, of Daphne near Athens, of St. Luke in Livadia, of the round temples of Salonica and of Ravenna. Mosaic is Byzantine and Christian, and the Arabs, who have merely a borrowed architecture, have even borrowed a great portion of their embellishment." The word "*mosaic*" was most probably derived from the word "*mosque*," for the adornment of which the Byzantine Greeks were much employed in producing these cubic glass stones.

and churches and chapels of all sects is becoming every day stronger; we appear anxious at last to throw off the title acquired by us, in common with the Turks, of "lovers of whitewash," as if in that practice simplicity was ensured.

There are sterile periods in history, as in years, which are succeeded by those of fertility; from the seed which is being scattered to-day we may reap a rich harvest which may help to nourish industry, commerce and art, and, by tending to impress new directions and tastes, may aid in dispelling a portion, at least, of the darkness which opposes the progress of the mass of human intelligence.

In concluding my labours, the kindness of the several gentlemen to whom I have had occasion to apply, during the progress of this work, demands my liveliest recognition.

At Vienna, Dr. Ferdinand Wolf; at Paris, MM. Libri, Champollion, and the Count de l'Escalopier united to forward the views of a stranger with a promptitude honourable to them in the service of literature.

At home, Sir Frederick Madden, Signor Panizzi and Mr. Eastlake, have likewise aided my exertions, by attentions and kindness, which have often, in the midst of difficulties, encouraged and cheered labours which by the concurrent sympathy of so many enlightened men, I have felt were not pursued without a prospect of advantage to the public.

ROBERT HENDRIE.

Note.—The characters in the title, printed with the specimens of different MSS. of Theophilus, are taken from a Manuscript now in the British Museum, executed by Greek artists for Melissenda (daughter of Baldwin II.), who married Fulco, king of Jerusalem, in 1131.

LIBER PRIMUS THEOPHILI,

QUI ET

RUGERUS.

BOOK THE FIRST OF THEOPHILUS,

CALLED ALSO

RUGERUS.

INCIPIUNT CAPITULA.

CHAPTERS.

ERRATA.

Page 97, line 30, *for* painting oil, *read* preparing oil.
101, *for* Pauselinos, *read* Panselinos.

PROLOGUS LIBRI PRIMI.

PROLOGUS THEOPHILI[1].

SENSIM per partes discuntur quælibet artes.
Artis pictorum prior est factura colorum.
Post ad mixturas commitat mens tua curas.
Hoc opus exerce, sed ad unguem cunta coherce,
Ut sit adornatum quod pinxeris et quasi natum.
Postea multorum documentis ingeniorum
Ars opus augebit, sicut liber iste docebit.

Theophilus, humilis presbyter, servus servorum Dei, indignus nomine et professione monachi, omnibus mentis desidiam animique vagationem utili manuum occupatione, et delectabili novitatum meditatione declinare et calcare volentibus, retributionem cœlestis præmii!

Legimus in exordio mundanæ creationis hominem, ad imaginem et similitudinem Dei conditum et inspiratione divini spiraculi animatum, tantæque dignitatis excellentia cæteris animantibus prærogatum; ut rationis capax divinæ prudentiæ, consilii ingeniique mereretur participium, arbitriique libertate donatus solius conditoris sui suspiceret voluntatem et revereretur imperium. Qui astu diabolico misere deceptus, licet propter inobedientiæ culpam privilegium immortalitatis amiserit, tamen scientiæ et intelligentiæ dignitatem adeo in pos-

[1] Prefatio libri primi non extat in Manuscripto Harleio: supplevimus ex Cod. Guelpherbytano.

PREFACE OF THEOPHILUS.

ALL arts are taught by degrees. The first process in art of the painter is the composition of colours. Let your mind be afterwards applied to the study of the mixtures. Practise this labour, but restrain all things with precision, that your painting may be beautiful and natural. Your artistic skill will afterwards be increased by the descriptions of many inventions, as this book will teach you.

I, Theophilus, an humble priest, servant of the servants of God, unworthy of the name and profession of a monk, to all wishing to overcome or avoid sloth of the mind or wandering of the soul, by useful manual occupation and the delightful contemplation of novelties, send a recompense of heavenly price.

We read in the exordium of mundane creation that man, made after the image and likeness of God and animated by the inspiration of the Divine breath, was also, by the excellence of so much dignity, raised above other living creatures; as capable of reason, he merited to participate in the counsel and genius of Divine providence, and, gifted with free-will, he beheld superior to himself but the will of his Maker and the obligation to reverence his decree. Wherefore, miserably deceived by diabolical astuteness, he lost the privilege of immortality through the fault of disobedience, yet so transmitted his power of wisdom and intelligence to

teritatis propaginem transtulit, ut quicunque curam sollicitudinemque addiderit, totius artis ingeniique capacitatem quasi hæreditario jure adipisci possit.

Hujusmodi intentionem humana suscipiens sollertia, et in diversis actibus suis insistens lucris et voluptatibus, per temporum incrementa, tandem ad prædestinata Christianæ religionis perduxit tempora, factumque est, ut quod ad laudem et gloriam nominis sui condidit dispositio divina, in ejus obsequium converteret plebs Deo devota. Quapropter quod ad nostram usque ætatem sollers prædecessorum transtulit provisio, pia fidelium non negligat devotio; quodque hæreditarium Deus contulit homini, hoc homo omni aviditate amplectatur et laboret adipisci.

Quo adepto, nemo apud se, quasi ex se et non aliunde accepto, glorietur; sed in Domino, a quo et per quem omnia, et sine quo nihil, humiliter gratuletur, nec concessa invidiæ sacculo recondat, aut tenacis armariolo cordis occultet, sed omni jactantia repulsa, hilari mente simpliciter quærentibus eroget, metuatque evangelicam illius negotiatoris sententiam, qui domino suo reconsignare dissimulans mnam fœneratam, omni beneficio privatus, oris sui judicio nequam servi promeruit notam.

Quam sententiam incurrere formidans, ego, indignus et pene nullius nominis homuncio, quod mihi gratis concessit, quæ dat omnibus affluenter et non improperat,

his posterity, that whoever would supply care and application might be able to acquire a capability of every art and science, as by an hereditary right.

In this manner, human industry, seizing upon this faculty and applying itself in its divers acts to gain and to pleasure, transmitted it, through the development of time, to the predestined epoch of the Christian religion, and it came to pass that a people devoted to God converted to his worship that which Divine ordinance had, to the praise and glory of His name, created. On this account, the pious devotion of the faithful may not neglect that which the careful prevision of our predecessors transmitted to our age; and may man embrace with all avidity that which God has conferred upon man, as an inheritance, and labour to acquire it.

Skilful in which let no one glorify himself inwardly, as if received from himself and not from elsewhere, but let him be thankful humbly in the Lord, from whom and through whom all things are received, and without whom, nothing; nor let him wrap his gifts in the folds of envy, nor hide them in the closet of an avaricious heart, but, all jealous feeling repelled, let him with cheerful mind answer with simplicity to those seeking him, and let him fear the judgment of the Gospel upon that merchant, who, failing to return to his lord a talent with accumulated interest, deprived of all reward, merited the censure from the mouth of his judge of "wicked servant."

Fearing to incur which sentence, I, frail and unworthy and almost without name, offer gratuitously to all desirous with humility to learn, that, which Divine authority, which affluently and not precipitately gives to all, gratuitously conceded to me, and I admonish them

divina dignatio, cunctis humiliter discere desiderantibus gratis offero, et ut in me benignitatem Dei recognoscant largitatemque mirentur, admoneo, et ut idem, si opera addiderint, sibi præsto esse, procul dubio credant insinuo.

Sicut enim homini quodcunque vetitum aut indebitum cujuscunque modi ambitione attemptare, sive rapina usurpare, iniquum est et detestabile; sic jure debitum et ex patre Deo hæreditarium intemptatum negligere aut contemptui ducere, ignaviæ adscribitur ac stultitiæ. Tu ergo quicunque es, fili carissime, cui Deus misit in cor campum latissimum diversarum artium perscrutari, et ut exinde, quod libuerit, colligas, intellectum curamque apponere, non vilipendas pretiosa et utilia quæque, quasi ea tibi sponte aut insperato domestica terra produxerit; quia stultus negotiator est, qui thesaurum subito fossa humo repererit, si illum colligere et servare neglexerit. Quod si tibi arbusta vilia myrrham, thus et balsama producerent, seu fontes domestici oleum, lac et mella profunderent, sive pro urtica et carduo cæterisque horti graminibus nardus et fistula diversorumque generum aromata crescerent, numquid his contemptis tanquam vilibus et domesticis ad extranea, nec meliora, sed fortassis viliora comparanda circuires terras et mares? et hoc te judice grandis foret stultitia. Quamvis enim soleant homines quæque pretiosa multo sudore quæsita, sumptuumque numerositate comparata, primo loco reponere, summaque tueri cautela: tamen si fortè interdum gratis occurrerint aut inveniantur paria seu meliora, non dissimili, imo majori servantur custodia.

that in me they may recognise the goodness and admire the generosity of God, and I advise them likewise that if to this their labours are added, they may believe beyond a doubt that excellence awaits them.

And as it is iniquitous and detestable to a man to appropriate through covetousness, in any manner, that which is unlawful, or undue, or to seize it with theft, so also to neglect untried, or contemptuously to turn from an heritage given as a right by God the Father, is to be ascribed to cowardice, and folly. Whoever thou art, therefore, dearest son, in whose heart God has placed the desire to explore the vast field of the divers arts, and to bring thereto intellect and care, that thou mayest afterwards collect therefrom that which may please thee, think not thou cheaply of any precious and useful things; as if the domestic soil produced them for thee spontaneously, or unsought for; he would be a foolish calculator who suddenly finding a treasure in a hole in the ground, should neglect to gather and keep it. But if for thee the common shrubs produced myrrh, thus and balsam, or the domestic springs poured forth oil, milk and honey, or, for the nettle and thistle and other weeds of the garden, grew spikenard and cinnamon and aromatics of various kinds, wouldst thou, these being despised as common and domestic, travel over lands and seas after foreign things not better, but perhaps more vile in comparison? this, in thine own judgment, would be a great folly. For however men are accustomed to place in the first rank and to keep with the greatest care some precious things sought with much labour and acquired with great expense, yet, if by chance they are sometimes met with cheaply, or like, or better things, are found, they are preserved with a similar, yes, with a greater care.

Quapropter, fili dulcissime, quem Deus omnino beatum fecit in hac parte, qua tibi gratis offeruntur, quæ multi marinos secantes fluctus cum summo periculo vitæ, famis ac frigoris artati necessitate; aut diuturna doctorum fessi servitute, omni modoque fatigati discendi desiderio, intolerabili tamen acquirunt labore; hanc DIVERSARUM ARTIUM SCHEDULAM avidis obtutibus concupisce, tenaci memoria perlege, ardenti amore complectere.

Quam si diligentius perscruteris, illic invenies quicquid in diversorum colorum generibus et mixturis habet Græcia; quicquid in electorum operositate, seu nigelli varietate novit Tuscia; quicquid ductili vel fusili, seu interrasili opere distinguit Arabia; quicquid in vasorum diversitate, seu gemmarum ossiumve sculptura auro decorat Italia; quicquid in fenestrarum pretiosa varietate diligit Francia; quicquid in auri, argenti, cupri et ferri, lignorum lapidumque subtilitate sollers laudat Germania.

Quæ cum sæpe relegeris et tenaci memoriæ commendaveris, hac vicissitudine instructionis me recompensabis, ut, quoties labore meo bene usus fueris, ores pro me apud misericordiam Dei omnipotentis, qui scit, me nec humanæ laudis amore, nec temporalis præmii cupiditate, quæ digesta sunt, conscripsisse, aut invidiæ livore pretiosum quid aut rarum subtraxisse, seu mihi peculiariter reservatum conticuisse, sed in augmentum honoris et gloriæ nominis ejus multorum necessitatibus succurrisse et profectibus consuluisse.

Wherefore, gentle son, whom God has rendered perfectly happy in this respect, that those things are offered to thee gratis which many, ploughing the sea-waves with the greatest danger to life, consumed by the hardship of hunger and cold, or subjected to the weary servitude of teachers, and altogether worn out by the desire of learning, yet acquire with intolerable labour, covet with greedy looks this "BOOK OF VARIOUS ARTS," read it through with a tenacious memory, embrace it with an ardent love.

Should you carefully peruse this, you will there find out whatever Greece possesses in kinds and mixtures of various colours; whatever Tuscany knows of in mosaic work, or in variety of enamel; whatever Arabia shows forth in work of fusion, ductility, or chasing; whatever Italy ornaments with gold, in diversity of vases and sculpture of gems or ivory; whatever France loves in a costly variety of windows; whatever industrious Germany approves in work of gold, silver, copper and iron, of woods and of stones.

When you shall have re-read this often, and have committed it to your tenacious memory, you shall thus recompense me for this care of instruction, that as often as you shall successfully have made use of my work, you pray for me for the pity of Omnipotent God, who knows that I have written these things, which are here arranged, neither through love of human approbation, nor through desire of temporal reward, nor have I stolen anything precious or rare through envious jealousy, nor have I kept back anything reserved for myself alone; but in augmentation of the honour and glory of His name, I have consulted the progress and hastened to aid the necessities of many men.

ERRATA.

Page xxx, line 3, *for* Vasari himself, *read* Malvasia.
xxxiii, line 3 of note, *for* 1 pound litharge (*spigelhars*), *read* 1 pound glass (or clear) resin.
Idem, line 5, *for* litharge, *read* resin.
97, line 30, *for* painting oil, *read* preparing oil.
101, *for* Pauselinos, *read* Panselinos.

BOOK I. OF THEOPHILUS.

INCIPIT LIBER PRIMUS

THEOPHILI MONACHI,

DE DIVERSIS ARTIBUS.

CAPUT I.

DE TEMPERAMENTO COLORUM IN NUDIS CORPORIBUS.

COLOR qui dicitur membrina, quo pinguntur facies et nuda corpora, sic componitur. Tolle cerosam, id est album, quod fit ex plumbo, et mitte eam non tritam, sed ita ut est siccam, in vas cupreum vel ferreum, et pone super prunas ardentes, et combure donec convertatur in flavum colorem. Deinde tere eum, et admisce ei albam cerosam et cenobrium[1], donec carni similis fiat. Quorum colorum mixtura in tuo sit arbitrio; ut si, verbi gratia, rubeas facies habere vis, plus adde cenobrii; si vero candidas, plus appone albi; si autem pallidas, pro cenobrio modicum prasini.

CAPUT II.

DE COLORE PRASINO.

QUI prasinus, est confectio quædam habens similitudinem viridi coloris et nigri, cujus natura talis est, quod non teritur super lapidem, sed missus in aquam resolvitur et per pannum diligenter colatur, cujus usus in recenti muro pro viridi colore satis utilis est.

[1] Vel sinopidem, *ex C. R.*

THE BEGINNING

OF

THE FIRST BOOK

OF

THEOPHILUS THE MONK,

UPON VARIOUS ARTS.

CHAPTER I.

OF THE MIXTURE OF COLOURS FOR THE NUDE.

THE colour which is called flesh colour, with which the face and the nude are painted, is thus composed. Take ceruse, that is white which is made from lead, and put it, not ground, but dry as it is, into a copper or iron vessel, and place it upon glowing coals, and burn it until it is converted into a yellow colour. Then grind it, and mix with it white ceruse, and cinnabar, until it is made like flesh. The mixture of these colours may be made according to your will; so that if you wish to have red coloured faces, add more cinnabar; but if clear complexions, put more white; if pallid however, add, for cinnabar, a little green.

CHAPTER II.

OF THE COLOUR CALLED PRASINUS.

WHICH prasinus is a preparation having the appearance of a green colour with black; such is the nature of which, that it is not ground upon the stone, but, placed in water it is dissolved, and is carefully strained through a cloth; its use is rather advantageous upon a new wall for a green colour.

CAPUT III.

DE POSC PRIMO.

CUM vero membrinam miscueris inde facies et nuda corpora impleveris, admisce ei prasinum et rubeum, qui comburitur ex ogra, et modicum cenobrii, et confice posc, ex quo designabis supercilia et oculos, nares, et os, mentum, et fossulas circa nares, et tempora, rugas in fronte et collo, et rotunditatem faciei, barbas juvenum et articulos manuum et pedum, et omnia membra, quæ distinguuntur in nudo corpore.

CAPUT IV.

DE ROSA PRIMA.

DEINDE misce cum simplici membrina modicum cenobrii et parum minii, et confice colorem, qui dicitur rosa, unde rubricabis maxillam utramque, os et mentum inferius, collum et rugas frontis modice, ipsam frontem super tempora ex utraque parte, nasum in longitudine et supernares ex utraque parte, articulos et cætera membra in nudo corpore.

CAPUT V.

DE LUMINA PRIMA.

POST hæc misce cum simplici membrina cerosam tritam, et compone colorem, qui dicitur lumina, unde illuminabis supercilia, nasum in longitudine et super foramina narium ex utraque parte, subtiles tractus circa oculos et tempora inferius, et mentum superius, juxta nares et os ex utraque parte, frontem superius, inter rugas frontis modice, et collum in medio, et circa aures, ac articulos manuum et pedum exterius et omnem rotunditatem manuum, pedum et brachiorum in medio.

CHAPTER III.

OF THE FIRST POSC, OR HALF SHADOW.

When you have mixed the flesh colour, and have filled in the faces and the nude with it, mix with it some deep green and the red which is burnt from ochre, and a little cinnabar; and prepare the half shadow, with which you will mark the eyebrows and eyes, the nostrils and mouth, the chin and the hollows round the nostrils, and the temples; the wrinkles in the forehead and neck, and the rounding of the face; the beards of young men, and the articulations of the hands and feet, and all members which are made apparent in the nude.

CHAPTER IV.

OF THE FIRST ROSE COLOUR.

Then mix with the simple flesh colour a little cinnabar and a little minium, and prepare the colour which is called rose, with which you will redden both cheeks, the mouth and lower part of the chin, the neck, and wrinkles of the forehead slightly, the forehead itself above the temples on either side, the nose in its length and over the nostrils on either side, the articulations and other members in the nude.

CHAPTER V.

OF THE FIRST RELIEF.

After this mix, with simple flesh colour, ceruse, ground, and compose a colour which is called relief, with which you will lighten the eyebrows, the nose in its length, and above the openings of the nostrils on either side, fine lines around the eyes, the lower part of the temples and upper part of the chin, about the nostrils and the mouth on either side, the upper part of the forehead, slightly between the wrinkles of the forehead, and in the middle of the neck and round the ears, also the articulations of the hands and feet outside, and all roundness in the centre of the hands, feet and arms.

CAPUT VI.

DE VENEDA IN OCULIS PONENDA.

DEINDE commisce nigrum cum modico albo, qui color vocatur veneda, et imple pupillas oculorum. Adde ei etiam de albo amplius, et imple oculos ex utraque parte, et album simplex linies inter pupillam et ipsum colorem, et cum aqua lavabis.

CAPUT VII.

DE POSC SECUNDO.

POSTEA accipe posc, de quo supra dictum est, et admisce ei amplius de prasino et rubeo, ita ut umbra sit anterioris coloris, et imple medium spatium inter supercilia et oculos, et sub oculis medium, et juxta nasum, et inter os et mentum, granos seu barbulas adolescentum, et palmas dimidias versus pollicem, et pedes supra minores articulos, et facies puerorum et mulierum a mento usque ad tempora.

CAPUT VIII.

DE ROSA SECUNDA.

DEINDE misce cum rosa cenobrium, et linies inde in medio oris, ita ut anterior superius inferiusque pareat, et fac subtiles tractus super rosam in facie, in collo et in fronte, et designabis inde articulos in palmis, et juncturas omnium membrorum et ungula.

CHAPTER VI.

OF THE VENEDA FOR PLACING UPON THE EYES.

Then mix black with a little white, which colour is called veneda, and fill up the pupils of the eyes. Add to it yet more white, and fill in the eyes on both sides, and lay white only between the pupil and this colour, and you will wash it with water.

CHAPTER VII.

OF THE SECOND POSC, OR SHADOW COLOUR.

Afterwards take the posc, which has been mentioned before, and mix with it more prasinus and red, so that it may become a shadow to the former colour, and fill up the middle space between the eyebrow and the eyes, and in the middle under the eyes, and about the nose, and between the mouth and the chin, the down or slight beards of youths, and the half-palms towards the thumb, and the feet over the smaller articulations, and faces of boys and women, from the chin to the temples.

CHAPTER VIII.

OF THE SECOND ROSE COLOUR.

Then mix cinnabar with rose colour, and paint with it in the middle of the mouth, so that the former colour may appear above and below it; and make fine touches upon the rose colour in the face, in the neck, and on the forehead, and mark the articulations with it in the palms, and the joints of all the members, and the nails.

CAPUT IX.

DE LUMINA SECUNDA.

ET si facies tenebrosa fuerit ut ei non sufficiat una lumina, adde ei amplius de albo et super priorem linies subtiles tractus per omnia.

CAPUT X.

DE CAPILLIS PUERORUM, ADOLESCENTUM ET JUVENUM.

POST hæc misce modicum nigrum cum ogra et imple capillos puerorum, et discerne eos cum nigro. Adde amplius nigri cum ogra et imple capillos adolescentum, et illumina cum prima. Adde amplius adhuc nigri et imple capillos juvenum, et illumina cum secundo.

CAPUT XI.

DE BARBIS ADOLESCENTUM.

MISCE prasin et rubeum et si vis rosæ modicum, et imple barbas adolescentum. Misce ogram et nigrum et rubeum, et imple capillos et illumina ogrâ modico nigro mixtâ, et ex eadem mixtura fac nigros tractus in barba.

CAPUT XII.

DE CAPILLIS ET BARBA DECREPITORUM ET SENUM.

MISCE modicum nigri cum cerosa, et imple capillos et barbas decrepitorum. Adde eidem colori amplius nigri et modicum rubei, et fac inde tractus, et illuminabis simplici cerosâ. Commisce rursum cerosæ amplius nigri, et imple ca-

CHAPTER IX.

OF THE SECOND RELIEF.

And if a face be dark so that one relief does not suffice for it, add more white to it, and paint fine touches over the first everywhere.

CHAPTER X.

OF THE HAIR OF BOYS, YOUTHS, AND YOUNG MEN.

After this, mix a little black with ochre, and fill in the hair of boys, and mark them out with black. Add more black with ochre, and fill in the hair of youths, and lighten with the first. Add yet more black, and fill in the hair of young men, and lighten it with the second.

CHAPTER XI.

OF THE BEARDS OF YOUTHS.

Mix deep green and red, and, if you like, a little rose colour, and fill in the beards of youths; mix ochre and black and red, and fill in the hair, and lighten with ochre mixed with a little black, and from the same mixture make the dark strokes in the beard.

CHAPTER XII.

OF THE HAIR AND BEARDS OF OLD AND DECREPIT MEN.

Mix a little black with ceruse, and fill in the hair and beards of decrepit men. Add more black and a little red to the same colour, and make the drawing with it, and lighten simply with ceruse. Mix again with ceruse some more black, and

pillos et barbas senum, et fac tractatos ex eodem colore, admixto ei nigro amplius et modico rubeo, et illumina eo unde decrepitos impleveras. Eo ordine, si vis, adhuc nigriores capillos et barbas compone.

CAPUT XIII.

DE EXUDRA ET CETERIS COLORIBUS VULTUUM.

DEINDE admisce rubeo modicum nigri, qui color dicitur exudra, et fac inde tractus circa vultuum, pupillas oculorum, et in medio oris, et subtiles tractus inter os et mentum. Post hæc cum simplici rubeo fac supercilia, et subtiles tractus inter oculos et supercilia et oculos inferius, in plena facie nasum in dextera parte[1], supernares ex utraque parte, et os inferius, et circa frontem et maxillas senum interius, et circa digitos manuum et articulos pedum interius, et in conversa facie circa nares in anteriori parte. Supercilia vero senum sive decrepitorum facies cum veneda, unde pupillas implesti. Deinde cum simplici nigro juvenum supercilia facies, ita ut superius aliquantulum rubei appareat, et oculos superius et foramina narium, et os ex utraque parte, et circa auriculas, manus et digitos exterius, et articulos et cæteros corporis tractus. Omnes vero tractus circa nuda corpora fac cum rubeo, et ungues designabis cum exteriori rosa.

CAPUT XIV.

DE MIXTURA VESTIMENTORUM IN LAQUEARI.

MISCE manisc cum folio sive cum nigro, et modico rubeo, et imple vestimentum. Admisce etiam modicum nigri et fac tractus. Deinde misce lazur cum modico manisc, sive

[1] Si ad dexteram partem respiciens pertracta vel figurata sit facies; aut in sinistra, si ad sinistram vertatur: *Ex Cod. Reg.*

fill in the hair and beards of old men, and make the drawings from the same colour with more black and a little red added, and lighten it with that with which you filled in the hair of decrepit men. In this order, if you wish, compose hair and beards still darker.

CHAPTER XIII.

OF EXUDRA AND OTHER COLOURS OF COUNTENANCES.

Then mix a little black with red, which colour is called exudra, and make drawings with it round the faces, the pupils of the eyes, and in the middle of the mouth, and fine touches between the mouth and the chin. After this, with simple red, make the eyebrows and fine lines between the eyes and eyebrows and below the eyes, the nose on the right side in full face, upon the nostrils on either side, and below the mouth, and about the forehead, and between the jaws of old men; and about the fingers of the hands, and within the articulations of the feet, and about the nostrils in the prominent part in a profile. But make the eyebrows of old or decrepit men with veneda, with which you filled in the eyes. Then make the eyebrows of young men with black simply, so that some red may show through above it, and the eyes in the upper part, and the openings of the nostrils, and in the mouth on both sides, and about the ears, hands and fingers outside, and the articulations and other drawings of the body. Make all touches round nude bodies with red, and mark the nails with an outside rose tint.

CHAPTER XIV.

OF THE MIXTURE FOR DRAPERY ON PLASTER.

Mix manisc with folium, or with black and a little red, and fill in a drapery; mix again a little black with it and make the drawing. Then mix lazur with a little manisc, or with

cum folio, sive cum eodem colore unde implesti, et illumina primum, cum puro lazur illumina superius. Post hæc misce parum albi cum lazur et fac subtiles et raros tractus. Imple vestimentum cum rubeo,[1] rubeum pallidum sit, adde modicum nigri. Inde misce amplius nigri cum eodem, et fac tractus. Deinde misce modicum rubei cum cenobrio et illumina primum. Post hæc adde modicum minii cum cenobrio, et illumina superius. Imple vestimentum cum cenobrio, et misce cum eodem modicum rubei, et fac tractus. Deinde misce modicum minii cum cenobrio, et illumina primum. Post hæc illumina cum simplici minio. Ad extremum misce modicum nigri cum rubeo, et fac exteriorem umbram. Misce purum viride cum ogra, ita ut de ogra plus sit, et imple vestimentum. Adde eidem colori modicum de suco et parum rubei, et fac tractus. Misce eidem colori unde implesti album, et illumina primum. Adde plus albi, et illumina exterius. Misce etiam cum superiori umbra plus suci et rubei et parum viridis, et exteriorem umbram fac. Misce succum folii cum cerosa, et imple vestimentum. Adde folii plus, et fac tractus. Adde plus cerosæ, et illumina. Post hæc cum simplici cerosa. Ad extremum modicum folii triti et modicum cenobrii misce cum priore umbra, et fac exteriorem. Et eodem colore imple aliud vestimentum. Adde eidem unde implesti, cerosam et modicum cenobrii, et illumina primum. Adde plus cerosæ, et illumina superius. Ad extremum misce modicum rubei cum priore umbra, et fac exteriorem. EX HAC MIXTURA FACIES TRIA GENERA VESTIMENTORUM, UNUM PURPUREUM, ALIUD VIOLATICUM, TERTIUM CANDIDUM. Misce modicum cenobrii cum auripigmento, et imple vestimentum. Adde parum rubei, et fac tractus. Cum simplici rubeo umbram exteriorem. Adde cum impletione plus auripigmenti, et illumina primum. Cum simplici auripigmento illumina superius.

[1] "et si." *Ms. Guelph.*

folium, or with the same colour with which you filled in, and lighten it the first time; with pure lazur lighten above this. After this, mix a little white with lazur, and make some few and fine touches.

Fill in a drapery with red, if the red be pale add a little black. Then mix more black with the same, and make the drawing. Afterwards mix a little red with cinnabar, and lighten the first time. After this, add a little minium with cinnabar, and relieve above it.

Fill in a drapery with cinnabar, and mix a little red with it, and make the drawing. Then mix a little minium with cinnabar, and lighten the first time. Afterwards relieve with simple minium. At last mix a little black with red, and make the outer shadow.

Mix pure green with ochre so that the ochre may predominate, and fill in a drapery. Add a little succus and a little red to the same colour, and make the drawing. Mix white with the same colour with which you filled in, and relieve a first time. Add more white, and lighten above it. Mix also with the above shadow colour more succus and red and a little green, and make the exterior shadow.

Mix juice of folium with ceruse, and fill in a drapery. Add more folium, and make the drawing. Add more ceruse, and lighten it; after this, with ceruse simply. At the last mix a little folium, ground, and a little cinnabar with the above shadow, and make the outside shadow.

Also with the same colour fill in another drapery. Add to the same, with which you filled in, ceruse and a little cinnabar, and lighten the first time; add more ceruse, and relieve above it. At last, mix a little red with the former shadow, and make the outer shade.

From this mixture make three kinds of drapery: one purple, another violet, the third white.

Mix a little cinnabar with orpiment, and fill in a drapery; add a little red, and make the drawing; make the outer shadow with simple red. Add more orpiment to that with which you filled in, and lighten the first time. Illumine above it with simple orpiment.

Misce viride cum succo, et adde modicum ogræ, et imple vestimentum. Adde etiam modicum nigri, et fac exteriorem umbram. Adde cum impletione plus viridis et illumina primum. Cum puro viridi illumina exterius, et si opus sit, adde ei modicum albi. Usus hujus vestimenti non est in muro. Misce auripigmentum cum indico, sive cum manisc, sive cum succo sambuci, et imple vestimentum. Adde amplius de succo, sive manisc,[1] de indico, et fac tractus. Adde modicum nigri, et fac umbram exteriorem. Deinde plus auripigmenti cum impletione, et illumina primum. Cum simplici auripigmento illumina superius. Auripigmentum et quicquid ex eo temperatur, nullam vim habet in muro. Misce manisc cum folio, et imple vestimentum. Adde etiam parum nigri, et fac exteriorem umbram. Cum simplici manisc illumina primum. Adde parum albi, et illumina superius. Misce ogram cum nigro, et imple vestimentum. Adde nigri plus, et fac tractus. Adde etiam plus, et fac umbram exteriorem. Adde ogræ plus cum impletione, et illumina primum. Cum ogra et rubeo fac similiter. Misce album et viride, et imple vestimentum. Cum simplici viridi fac tractus. Adde parum succi, et fac umbram exteriorem. Adde plus albi cum impletione, et illumina primum. Cum simplici albo illumina superius. Misce modicum nigri et parum rubei cum albo, et imple vestimentum. Adde plus rubei et parum nigri, et fac tractus. Adde etiam amplius nigri et rubei, et fac umbram exteriorem. Adde cum impletione plus albi, et illumina primum. Cum simplici albo, illumina exterius. Misce similiter nigrum cum albo. Eodem modo misce ogram cum albo, et in umbra eidem adde modicum rubei.

[1] "sive." *Ms. Guelph.*

Mix green with succus, and add a little ochre, and fill in a drapery. Add also a little black, and make the outer shadow; add more green to that with which you filled in, and relieve the first time; with pure green lighten above it, and, if it is needed, add to it a little white. THIS DRAPERY IS NOT USED UPON A WALL.

Mix orpiment with indigo or with manisc, or with juice of the elder, and fill in a drapery; add more succus, or manisc, and indigo, and make the drawing. Add a little black, and make the outer shadow, then more orpiment with the ground colour, and lighten the first time; relieve above it with simple orpiment. Orpiment, and whatever is compounded from it, have no duration upon a wall.

Mix manisc with folium, and fill in a drapery; add also a little black, and make the outer shadow; with simple manisc lighten the first time; add a little white, and relieve above it.

Mix ochre with black, and fill in a drapery; add more black, and make the drawing; add yet more and make the outer shadow; add more ochre to the ground colour, and lighten the first time. Act in the same manner with ochre and red.

Mix white and green, and fill in a drapery; make the drawing with green alone; add a little succus and make the outer shadow; add more white to the ground colour and lighten the first time; with white alone relieve above it.

Mix some black and a little red with white, and fill in a drapery; add more red and a little black, and make the drawing; add yet more black and red, and make the outer shadow; add more white to the ground colour, and lighten the first time; with simple white relieve outside.

Mix similarly black with white.

In the same manner mix ochre with white, and in the shadow of the same colour add a little red.

CAPUT XV.

DE MIXTURA VESTIMENTORUM IN MURO.

IN muro vero imple vestimentum cum ogra, addito ei modico calcis, propter fulgorem, et fac umbras ejus sive cum simplici rubro, sive cum prasino, sive ex posc, qui fiat ex ipsa ogra et viridi. Membrina in muro miscetur ex ogra et cenobrio et calce, et posc ejus et rosa et lumina fiant ut supra. Cum imagines vel aliarum rerum effigies pertrahuntur in muro sicco, statim aspergatur aqua, tam diu donec omnino madidus sit. Et in eodem humore liniantur omnes colores, qui supponendi sunt, qui omnes calce misceantur, et cum ipso muro siccentur ut hæreant. In campo sub lazur et viridi, ponatur color, qui dicitur veneda, mixtus ex nigro et calce, super quem, cum siccus fuerit, ponatur in suo loco lazur tenuis cum ovi mediolo abundanter aquâ mixto temperatus, et super hunc iterum spissior propter decorem. Viride quoque misceatur cum succo et nigro.

CAPUT XVI.

DE TRACTU QUI IMITATUR SPECIEM PLUVIALIS ARCUS.

TRACTUS qui imitatur speciem pluvialis arcus conjungitur diversis coloribus, videlicet cenobrio et viridi; item cenobrio et manisc; item viridi et ogra; item viridi et folio; item folio et ogra; item manisc et ogra; item cenobrio et folio; qui hoc modo componuntur. Fiunt duo tractus æqua latitudine; unus ex rubeo, calce mixto, in muro, sub cenobrio, ita ut vix quarta pars sit rubei; in laqueari vero ipsum cenobrium similiter cum creta mixtum. Alter vero viridis

CHAPTER XV.

OF THE MIXTURE FOR DRAPERY ON A WALL.

But on a wall, fill in a drapery with ochre, a little lime being added to it, on account of the brilliancy, and make its shadows either with red simply, or with prasinus, or from posc, which is made from the same ochre and green. Flesh colour upon a wall is made from ochre and cinnabar and lime, and its posc and rose colour and light are made as before. When figures, or likeness of other things, are portrayed on a dry wall, it is first sprinkled with water until at length it is completely soaked. And in this humidity all colours, which are superposed, are painted, all which are mixed with lime, and let them dry with the wall itself, that they may adhere. A colour is laid as a ground, under lazur and green, which is called veneda, mixed from black and lime, upon which, when dry, lazur is laid in its place thinly, tempered with yoke of egg abundantly tempered with water, and over this again, more thickly because of its beauty. Green also is mixed with succus and black.

CHAPTER XVI.

OF THE DRAWING WHICH IMITATES THE APPEARANCE OF THE RAINBOW.

A drawing which imitates the appearance of the rainbow is combined from different colours, namely cinnabar and green; likewise cinnabar and manisc; also green and ochre; and green and folium; also folium and ochre; also manisc and ochre; likewise cinnabar and folium; which are composed in this manner. Two traits of equal breadth are made, one from red; mixed with lime upon a wall under cinnabar, so that scarcely a fourth part be of red, but on plaster the same cinnabar mixed in like manner with chalk; the other trait

pari modo mixtus absque suco, et inter eos fiat albus tractus. Deinde misce ex cenobrio et albo quot colores volueris, ita ut primus sit modicum cenobrii, secundus plus, tertius amplius, quartus adhuc plus, donec pervenias ad simplex cenobrium. Deinde admisce eidem modicum rubeum. Deinde simplex rubeum. Post hæc rubeum nigro admisce; ad ultimum nigrum. Simili modo commisce colores ex viridi et albo, donec pervenias ad simplex viride. Deinde admisce ei modicum sucum. Commisce iterum, et adde plus suci. Post hæc misce modicum nigri; deinde plus; ad ultimum simplex nigrum. Umbras vero in ogra facies cum rubeo; ad ultimum addito nigro. Umbras manisc cum folio; ad ultimum addito nigro. Umbras folii cum rubeo, addito nigro ad ultimum. Qui colores ita ponendi sunt, ut ex medio pallidiores tractus procedant, et ita ascendant usque ad exterius nigrum. Horum tractuum nunquam plus quam duodecim esse possunt in utroque colore. Et si volueris tot, sic tempera mixturas, ut simplex in septimo loco ponas. Si volueris novem, in sexto loco simplex pone. Si volueris octo vel septem, in quinto loco simplex pone. Si volueris sex, in quarto. Si quinque, in tertio. Si quatuor vel tres, non interponas eis simplex, sed eum, qui ante simplicem poni deberet habeas pro simplici, et eidem admisce umbram usque ad exterius nigrum. Hoc opere fiunt throni rotundi et quadranguli, et tractus circa lumbos, et arborum stipites cum ramis, et columpnæ, et turres rotundæ, et sedilia et quicquid rotundum apparere velis. Fiunt etiam arcus super columnas in domibus eodem opere; sed uno colore, ita ut interius album sit et exterius nigrum. Turres rotundæ fiunt de ogra, ita ut in medio sit tractus albus, et ex utraque parte procedat ogra omnino pallida et paulatim trahens croceum colorem usque antepenultimum tractum, cum quo misceatur modicum rubeum; deinde amplius, sic tamen ut nec simplex ogra nec simplex rubeum appareat. Eodem modo et eadem mixtura fiunt turres rotundæ ex nigro et albo. Stipites arborum commiscentur ex viridi et ogra,

green, mixed in the same manner, without succus, and between them let a white trait be made. Then mix, from cinnabar and white, what tints you wish, so that the first may possess little cinnabar, the second more, the third more still, the fourth yet more, until you arrive at pure cinnabar. Then mix a little red with the last; then use pure red. After this mix red with black; at the last use black. In a similar manner mingle together colours from green and white, until you arrive at pure green. Then add to it a little succus, mix again, and add more succus, after this admix a little black, then more, at last pure black. But you make shadows on ochre with red; black being added at the last. Shadow manisc with folium, black being added at the last. Shadow folium with red, black being added at the last. These colours are so applied, that the paler tints may issue from the centre and so increase until they arrive at the black, outside. More than twelve of these traits may never exist in each colour; and, if you wish as many, so temper the mixtures, that you place the pure colour in the seventh row. If you wish nine, place the pure colour in the sixth row. If you wish eight or seven, place the pure colour in the fifth. If you wish six, in the fourth. If five, in the third. If four or three, do not interpose any pure colour, but leave that one for a pure colour which should have been placed before the pure colour, and mingle its shadow colour towards the outer black. In this manner circular and quadrangular thrones are made, and drawings round borders, and branches of trees with their boughs, and columns and round towers and seats, and whatever you wish should appear round. Arches are also made upon columns in houses by the same means, but in one colour, so that the inner part is white and the outer black. Round towers are made of ochre, and so that the white stroke may be in the middle, and on either side may spread quite a pale ochre and a little inclining to saffron colour until the last plan but one; with which a little red is mixed; then more, so however, that neither pure ochre nor pure red may appear. In the same way and with the same mixture round towers are made with black and white Branches of trees are mixed from green and ochre, a little

addito modico nigro et succo. Quo colore pinguntur etiam terra et montes. Fiunt etiam terra et montes ex viridi et albo sine succo, ita ut interius sit pallidum, exterius trahat umbras mixtas cum modico nigro. Omnes colores, qui aliis supponuntur in muro, calce misceantur propter firmitatem. Sub lazur et manisc et sub viridi ponatur veneda; sub cenobrio rubeum; sub ogra et folio iidem colores calce mixti.

CAPUT XVII.

DE TABULIS ALTARIUM ET OSTIORUM, ET GLUTINE CASEI.

TABULÆ altarium sive ostiorum primum particulatim conjungantur junctorio instrumento, quo utuntur doliarii sive tornarii. Deinde componantur glutine casei, quod hoc modo fit. Caseus mollis minutatim incidatur et aqua calida in mortariolo cum pila tamdiu lavetur, donec[1] multotiens infusa pura inde exeat. Deinde idem caseus attenuatus manu mittatur in frigidam aquam donec indurescat. Post hæc teratur minutissime super ligneam tabulam æqualem cum altero ligno, sicque rursum mittatur in mortarium et cum pila diligenter tundatur addita aqua cum viva calce mixta, donec sic spissum fiat, ut sunt feces. Hoc glutine tabulæ altarum conpaginatæ, postquam siccantur, ita sibi adhærent, ut nec humore nec calore disjungi possint. Postmodum æquari debent planatorio ferro, quod curvum et interius acutum habet duo manubria, ut ex utraque manu trahatur, unde raduntur ostia, et scuta, donec omnino fiant plana. Inde cooperiantur crudo corio equi, vel asini, quod aqua madefactum, statim ut pili fuerint erasi, aqua aliquantum extorqueatur, et ita humidum cum glutine casei superponatur.

[1] aqua, *in cæteris omnibus MSS. additur.*

black and succus added; with which colour also the earth and mountains are painted. The earth and mountains are also made with green and white, without succus, the interior being made pale, the exterior showing shadows mixed with a little black. All colours which are placed under others on a wall are mixed with lime for solidity. Veneda is laid under lazur and manisc, and under green; red under cinnabar; under ochre and folium, the same colours, mixed with lime.

CHAPTER XVII.

OF THE TABLETS OF ALTARS AND DOORS, AND OF THE GLUE OF CHEESE.

The tablets of altars, or of doors, are first carefully fitted together with the joining instrument which carpenters or vat makers use; they are then joined with the glue of cheese, which is made in this manner. Soft cheese is cut very small, and is washed with warm water in a small mortar with a pestle, until, being frequently poured in, the water comes away pure. Then this cheese, compressed by the hand, is put into cold water until it hardens. After this it is very finely ground, with another piece of wood, upon a smooth wooden table, and in this state it is again placed in the mortar, and is carefully ground with the pestle, water mixed with quick lime being added, until it is made as thick as lees. The tablets of altars fastened together with this glue, after they are dry, so adhere together, that neither heat nor humidity are able to disjoin them. They should afterwards be smoothed with a planing iron, which, curved and sharp inside, has two handles, so that it may be drawn by both hands, (with which doors and shields are shaved,) until they are made perfectly smooth. They are then covered with the untanned skin of a horse, or ass, which is soaked in water; as soon as the hairs have been scraped off, some water is squeezed from it, and thus moist, it is superposed with the curd glue.

CAPUT XVIII.

DE GLUTINE CORII ET CORNUUM CERVI.

QUO diligenter exsiccato, tolle incisuras ejusdem corii similiter exsiccatas et diligenter incide particulatim, et accipiens cornua cervi minutatim confracta malleo ferrarii, super incudem, compone in ollam novam, donec sit dimidia, et imple eam aqua, sicque adhibe ignem donec excoquatur tertia pars ejusdem aquæ, sic tamen ut non bulliat; et ita probabis: fac digitos tuos humidos eadem aquâ, et cum refrigerati fuerint, si sibi adhærent, bonum est gluten; sin autem, tamdiu coque donec sibi adhæreant. Deinde effunde ipsum gluten in vas mundum, et rursum imple ollam aquâ, et coque sicut prius, sicque facias usque quater.

CAPUT XIX.

DE ALBATURA GYPSI.

POSTHÆC tolle gypsum more calcis combustum, sive cretam, quâ pelles dealbantur, et tere diligenter super lapidem cum aqua: deinde mitte in vas testeum, et infundens gluten corii, pone super carbones, ut gluten liquefiat, sicque linies cum pincello super ipsum corium tenuissime; ac deinde, cum siccum fuerit, linies aliquantulum spissius; et si opus fuerit, linies tertio. Cumque omnino siccum fuerit, tolle herbam, quæ vocatur asperella, quæ crescit in similitudinem junci et est nodosa; quam cum in æstate collegeris, siccabis in sole, et ex ea fricabis ipsam dealbaturam, donec omnino plana et lucida fiat[1].

[1] Si vero defuerit corium ad cooperiendum tabulas, eodem modo et eodem glutine cooperiantur cum panno, mediocriter novo, lini, vel canabi.—*Ex Cod. Reg. Parisii.*

CHAPTER XVIII.

OF GLUE OF SKINS AND STAG-HORNS.

THE above being carefully dried, take cuttings of the same skins, dried in like manner, and carefully cut them up into small pieces, and taking the stag-horns, broken very small with a smith's hammer upon an anvil, place them together in a new pot, until it is half full, and fill it up with water, and so apply fire until a third part of this water be evaporated, so, however, that it may not boil. And you will thus try it; moisten your fingers with this water, and if, when they have become cool, they adhere together, the glue is good; but if not, cook it until they do adhere together. Then pour this glue into a clean vessel and again fill the pot with water, and simmer it as before; and do this four times.

CHAPTER XIX.

OF THE WHITE GROUND OF GYPSUM.

AFTER this take gypsum, burnt like lime, or chalk with which skins are whitened, and carefully grind it with water upon a stone, then place it in a baked earthen vessel, and, pouring in some glue made from skins, place it over the coals, that the glue may liquefy, and in this manner paint over the skin very thinly with a pencil, and when it is dry, paint somewhat thicker, and, if needed, paint a third time. When it is quite dry, take the herb called shave-grass which grows like a bulrush, and is ragged; when you have gathered it in summer you will dry it in the sun, and will rub this whitening with it until it is made everywhere smooth and polished [1].

[1] But if a skin is wanting for covering tablets, they are covered with canva not too new, with the same glue and in the same manner. *Cod. Guelph. et Harlei. in fine, cap.* 21.

CAPUT XX.

DE RUBRICANDIS OSTIIS ET OLEO LINI.

SI autem volueris ostia rubricare tolle oleum lini, quod hoc modo compones. Accipe semen lini, et exsicca illud in sartagine super ignem sine aqua. Deinde mitte in mortarium, et contunde illud pilâ donec tenuissimus pulvis fiat, rursumque mittens illud in sartaginem, et infundens modicum aquæ, sic calefacies fortiter. Postea involve illud in pannum novum, et pone in pressatorium, in quo solet olivæ, vel nucum, vel papaveris oleum exprimi, ut eodem modo etiam istud exprimatur. Cum hoc oleo tere minium sive cenobrium super lapidem sine aqua, et cum pincello linies super ostia, vel tabulas, quas rubricare volueris, et ad solem siccabis. Deinde iterum linies, et rursum siccabis. Ad ultimum vero superlinies ei gluten quod vernition dicitur, quodque hoc modo conficitur.

CAPUT XXI.

DE GLUTINE VERNITION.

PONE oleum lini in ollam novam parvulam, et adde gummi[1] quod vocatur fornis, minutissime tritum, quod habet speciem lucidissimi thuris, sed cum frangitur fulgorem clariorem reddit. Quod cum super carbones posueris, coque diligenter sic ut non bulliat, donec tertia pars consumatur, et cave a flamma, quia periculosum nimis est, et difficile exstinguitur si accendatur. Hoc glutine omnis pictura superlinita[2], fit et decora ac omnino durabilis[3].

[1] In C. R., "Arabici" *additur.*—[2] "Lucida fit et decora," *legitur in MSS. Guelph. et Parisii.*—[3] "Si vero defuerit corium ad cooperiendas tabulas, eodem modo et eodem glutine cooperiantur cum panno lini mediocriter novo."—*Malè locata est, vide in fine cap.* xix. *non legitur in C. R. Parisii.*"

CHAPTER XX.

OF REDDENING DOORS, AND OF LINSEED OIL.

If, however, you wish to redden panels, take linseed oil, which you make in this manner. Take linseed and dry it in a pan over the fire, without water. Then put it into a mortar and bruise it with the pestle until it becomes a very fine powder; placing it again in the pan, and pouring a little water upon it, make it thus very hot. Afterwards fold it in a new cloth and place it in the press, in which olive, or walnut, or poppy oil is accustomed to be expressed, that this also may be expressed in the same manner. With this oil grind minium, or cinnabar, upon the stone, without water, and paint over the doors or tablets, which you wish to redden, with a pencil, and you will dry them in the sun. Then paint them again, and again dry them. At last cover them over with that gluten which is called varnish, and which is made in this manner.

CHAPTER XXI.

OF THE VARNISH GLUTEN.

Put linseed oil into a small new pot, and add, very finely powdered, the gum which is called fornis, which has the appearance of the most lucid Thus, but when broken, it yields a brighter lustre. When you have placed which over the fire, cook carefully, so that it may not boil up, until a third part is consumed, and guard against the flame, because it is very dangerous and is extinguished with difficulty if it be raised. Every painting, covered over with this gluten, is made both beautiful and for ever durable.

CAPUT XXII.

DE EODEM.

COMPONE quatuor lapides, qui possint ignem sustinere, ita ut non resiliant, et super ipsos pone ollam rudem, et in eam mitte supra dictum gummi fornis, quod Romane glassa dicitur [1], et super os hujus ollæ pone ollulam minorem, quæ habet in fundo modicum foramen, et circumlinies ei pastam, ita ut nihil spiraminis inter ipsas ollas exeat. Deinde suppone ignem diligenter, donec ipsum gummi liquefiat. Habebis etiam ferrum gracile et manubrio impositum, unde commovebis ipsum gummi, et cum sentire possis quando omninò liquidum sit. Habeas quoque ollam tertiam juxta super carbones positam, in qua sit oleum lini calidum; et cum gummi penitus liquidum fuerit, ita ut extracto ferro quasi filum trahatur, infunde ei oleum calidum et ferro commove, et sic insimul coque ut non bulliat, et interdum extrahe ferrum, et lini modice super lignum sive super lapidem, ut probes densitatem ejus. Et hoc caveas in pondere, ut sint duæ partes olei, et tertia gummi. Cumque ad libitum tuum coxeris diligenter, ab igne removens et discooperiens refrigerari sine.

CAPUT XXIII.

DE SELLIS EQUESTRIBUS ET OCTOFORIS.

SELLAS autem equestres et octoforos, id est sellas plicatorias, scabella, cæteraque, quæ sculpuntur, et non possunt corio vel panno cooperiri, mox ut raseris ferro, fricabis asperella, sicque bis dealbabis, et cum sicca fuerint, rursum asperella planabis. Posthæc in circino et regula metire, et

[1] "aliter Arabicum,' *ex C. R. Parisii.*

CHAPTER XXII.

OF THE SAME.

Place together four stones which may be able to sustain the fire without flying to pieces, and place a common pot upon them, and put into it the above mentioned gum fornis, which in Romaic is called glassa, and upon the mouth of this pot place a smaller pot, which has a small hole in the bottom, and lute a paste round it, so that no vapour may come out between these pots. Then place fire carefully underneath, until this gum liquefy. You will also have a thin iron rod fitted to a handle, with which you will stir this gum, and with which you can feel when it is quite liquid. Have also a third pot nigh, placed upon the coals, in which is hot linseed oil, and when the gum is quite liquid, so that the iron being extracted a kind of thread is drawn out with it, pour the hot oil into it and stir it with the iron, and thus cook them together that they boil not violently, and at times draw out the iron and daub a little over a piece of wood or stone, to try its substance. And take care in this, that in weight there are two parts of oil and the third part of gum. And when you have carefully cooked it to your wish, removing it from the fire and uncovering it, allow it to cool.

CHAPTER XXIII.

OF SADDLES AND LITTERS.

Saddles and octofori, that is, folding chairs, footstools, and other things which are sculptured and cannot be covered with leather or canvas, you will polish with the grass, as soon as you have scraped them with an iron, and in this state will whiten them over twice; and when they are dry will smooth them again with the grass. After this, measure them with the

dispone opus tuum, videlicet imagines aut bestias, vel aves et folia, sive quodcunque pertrahere volueris. Quo facto si decorare volueris opus tuum, auri petulam impones, quam tali modo facies.

CAPUT XXIV.

DE PETULA AURI.

TOLLE pergamenam Græcam, quæ fit ex lana lini[1] et fricabis eam ex utraque parte cum rubeo colore, qui comburitur ex synopide, id est ogra, minutissime trito et sicco, et polies eam dente castoris, sive ursi, vel apri, diligentissime, donec lucida fiat, et idem color ipsa fricatione adhæreat. Deinde incide forcipe ipsam pergamenam per partes quadras ad latitudinem quatuor digitorum, æqualiter latas et longas. Postmodum facies eadem mensura ex pergameno vituli quasi marsupium, et fortiter consues, ita amplum, ut multas partes rubricatæ pergamenæ possis implevere. Quo facto, tolle aurum purum et fac illud attenuari malleo super incudem æqualem diligentissime, ita, ut nulla sit in eo fractura, et incide illud per quadras partes ad mensuram duorum digitorum. Deinde mittes in illud marsupium unam partem rubricatæ pergamenæ, et supra eam unam partem auri in medio, sicque pergamenam et rursus aurum; atque ita facies donec impleatur marsupium, et aurum sit semper in medio commixtum. Dehinc habeas malleum fusilem ex auricalco, juxta manubrium gracilem et in plana latum, unde percuties ipsum marsupium super lapidem magnum et æqualem, non graviter, sed moderatè; et cum sæpius respexeris, considerabis, utrum velis ipsum aurum omnino tenue facere, vel mediocriter spissum. Si autem supercreverit aurum in attenuando et marsupium excesserit, præcides illud forcipe parvulo et levi, tantummodo ad hoc opus facto. Hæc est ratio

[1] "id est papirum," *ex C. R.*

compass and rule, and dispose your work, that is, figures or animals, or birds and foliage, or whatever you may wish to portray. Which done, if you wish to ornament your work, lay on gold leaf, which you make in this manner.

CHAPTER XXIV.

OF GOLD LEAF.

Take Greek parchment[1], which is made from linen cloth, and you will rub it on both sides with a red colour which is burned from sinoper, that is ochre, very finely ground and dry, and polish it with a beaver's tooth, or that of a bear or wild boar; very carefully, until it becomes shining, and that the colour may adhere through the friction. Then cut up this parchment with scissors, into square pieces, to the size of four fingers, equally broad and long. Afterwards make a kind of purse of vellum parchment, of the same dimension and strongly sewed, ample enough that you may fill into it many pieces of reddened parchment. Which being done, take pure gold and make it very thin with a hammer upon an even anvil, very carefully, so that there be no fracture in it, and cut it into four parts to the measure of two fingers. Then place in this purse one piece of reddened parchment, and upon it one piece of gold in the midst, and then parchment, and again gold; and do thus until you have filled up the purse, and so that the gold may always be placed inside. Then have a mallet cast from yellow brass, small towards the handle, and large in the flat part, with which you strike the purse upon a large and flat stone, not heavily, but moderately; and when you have frequently inspected it, you will consider whether you wish to make the gold very thin or moderately thick. If, however, the gold should have overspread in thinning and have exceeded the limits of the purse, cut it off with small and light scissors made altogether for this use. This is the fashioning of gold leaf. When you

[1] "That is, paper."—*From the Paris MS.*

aureæ petulæ. Quam cum secundum libitum tuum attenuaveris, ex ea incides forcipe particulas quantas volueris, et inde ordinabis coronas aureas circa capita regulorum, et stolas et oras vestimentorum, et cætera ut libuerit.

CAPUT XXV.

DE IMPONENDO AURO.

IMPONENDO aurum, tolle clarum, quod percutiter ex albugine ovi sine aqua, et inde cum pincello leniter linies locum in quo ponendum est aurum, et cauda ejusdem pincelli in ore tuo madefacta, continges unum cornu incisæ petulæ, et ita elevans cum summa velocitate impones, et cum pincello æquabis. Ea hora oportet te a vento cavere, et ab halitu continere, quia si flaveris, petulam perdes et difficile reperies. Quæ cum posita fuerit et siccata, ei, si volueris, eodem modo alteram superpone, et tertiam similiter, si opus fuerit, ut eo lucidius cum dente sive cum lapide polire possis. Hanc etiam petulam, si volueris, in muro et laqueari eodem modo imponere poteris. Quod si aurum non habueris, petulam stagni accipies, quam hoc modo facies.

CAPUT XXVI.

DE PETULA STAGNI.

STAGNUM purissimum attenuabis diligenter super incude [1] malleo, quantas et quam tenues partes volueris. Et cum aliquantulum attenuari cœperint, purgabis eas in una parte panno laneo, et carbonibus siccis minutissime tritis, ac iterum percuties malleo, rursumque fricabis panno et carbonibus, sic-

[1] "incundem ?"

shall have thinned it to your mind, cut from it with the scissors what pieces you wish, and with it fashion golden crowns round the heads of rulers, and round stoles, and borders of draperies and other things, as it may please you.

CHAPTER XXV.

OF LAYING ON THE GOLD.

In laying on gold take the clear part of the white of egg, which is beat up without water, and then with a pencil paint lightly over the place in which the gold is to be placed, and, the handle of the same pencil being wetted in your mouth, touch one corner of the cut leaf, and so elevating it, lay it on with the greatest quickness, and spread it even with a brush. And at that moment you must beware of a current of air and refrain from breathing, because if you blow you lose the leaf and with difficulty recover it. When this is laid on and dried, superpose another upon it, if you wish, in the same manner, and a third likewise, if it is necessary, that you may be able to polish it more brightly with a tooth or a stone. You can also if you wish lay this leaf upon a wall, and on a ceiling, in the same manner. But if you have not gold, take a leaf of tin, which you make in this manner.

CHAPTER XXVI.

OF TIN LEAF.

Thin carefully the purest tin upon the anvil with a mallet, as many pieces and as thin as you wish. And when they have begun slightly to attenuate, clean them on one side with a linen cloth and dry charcoal, most finely powdered, and again beat them with the mallet, again rub them with the cloth and charcoal, and do thus alternately until you have

que singulis vicibus facies, donec omnino attenuaveris. Post hæc fricabis eas leniter dente apri super ligneam tabulam æqualem, usque quo lucidæ fiant.

Deinde conjunges easdem partes unam ad alteram super ipsam tabulam, et adhærebis eas singulas ad lignum cum cera, ne possint moveri, et superlinies eas manu tua ex supradicto glutine vernition atque siccabis ad solem. Postmodum accipe virgas ligni putridi, quas cum Aprili incideris, findes per medium et siccabis super fumum. Dehinc auferes exteriorem corticem, et interiorem, qui est croceus, rades in patella munda, addens ei crocum ad quintam partem; et perfunde hæc vino veteri sive cervisia abundanter, et cum ita per noctem steterit, in crastinum calefacies super ignem donec liquefiat[1]; sicque impones tabulas stagneas singulatim, et frequenter elevabis, donec consideres, quod aureolum colorem sufficienter trahant. Postque rursum adhærebis eas ligneæ tabulæ superliniens gluten sicut prius, et cum siccatæ fuerint, jam habes stagneas petulas, quas impones operi tuo secundum libitum glutine corii. Ac deinceps accipe colores quos imponere volueris, terens eos diligenter oleo lini sine aqua, et fac mixturas vultuum ac vestimentorum sicut superius aqua feceras, et bestias sive aves aut folia variabis suis coloribus, prout libuerit.

CAPUT XXVII.

DE COLORIBUS OLEO ET GUMMI TERENDIS.

OMNIA genera colorum eodem genere olei teri et poni possunt in opere ligneo, in his tantum rebus quæ sole siccari possunt, quia quotiescunque unum colorem imposueris, alterum ei superponere non potes, nisi prior exsiccetur, quod imaginibus[2] diuturnum ac tædiosum est nimis. Si autem volueris

[1] "tepefiat," *in cæteris Codicibus.*—[2] "et aliis picturis." *ex C. R.*

made them quite thin. After this rub them gently with a boar's tooth, upon a flat wooden tablet, until they become shining.

Then join together the same pieces, upon this tablet, one to another, and attach them singly to the wood with wax, so that they cannot be moved, and superpose with your hand the before-mentioned varnish gluten, and you will dry them in the sun. Afterwards take sticks of rotten wood, which you cut in April, split them through the middle, and dry them in the smoke. Then take off the outer bark, and scrape the inner, which is yellow, into a clean vessel, adding to it a fifth part saffron; and pour over this a quantity of old wine, or beer, and when it has thus stood a night, on the morrow warm it upon the fire until it liquefy [1], and so place in it the tin leaves one by one, and lift them up frequently, until you are of opinion that they show the golden colour sufficiently. Afterwards you will again attach them to the wooden tablet, varnishing them over with gluten as before, and when they are dry, you have ready tin leaves, which you may place upon your work according to your wish with skin-glue. And then take the colours which you wish to lay on, grinding them carefully with linseed oil, without water, and make tints for faces, and for draperies, as you before made with water, and you will vary beasts, or birds, or leaves, in their colours, as it may please you.

CHAPTER XXVII.

OF COLOURS GROUND WITH OIL AND GUM.

All sorts of colours can be ground and laid upon woodwork, with the same kind of oil, in those things only which can be dried in the sun; because each time that you have laid on one colour, you cannot superpose another upon it until the first has dried, which, for figures [2], is excessively long and tedious.

[1] "it is warm," *in the other manuscripts.*—[2] "and other pictures," *from the Codex Regius.—Paris.*

opus tuum festinare, sume gummi, quod exit de arbore ceraso sive pruno, et concidens illud minutatim pone in vas fictile, et aquam abundanter infunde, et pone ad solem, sive super carbones in hieme, donec liquefiat gummi, et ligno rotundo commisce. Deinde cola per pannum, et inde tere colores et impone. Omnes colores et mixturæ eorum hoc gummi teri et poni possunt, præter minium et cerosam et carmin, qui claro ovi terendi et ponendi sunt. Viride Hispanicum non misceatur suco sub glutine, sed per se cum gummi glutine ponatur. Aliud vero miscere potes, si volueris.

CAPUT XXVIII.

QUOTIENS IIDEM COLORES PONENDI SINT.

OMNES colores, sive oleo sive gummi tritos, in ligno ter debes ponere, et pictura perfecta atque siccata, delato opere ad solem, diligenter linies glutine vernition, et cum defluere cœperit a calore, leniter manu fricabis, atque tertio sic facies, et tunc sine donec penitus exsiccetur.

CAPUT XXIX.

DE PICTURA TRANSLUCIDA.

FIT etiam pictura in ligno, quæ dicitur translucida, et apud quosdam vocatur aureola, quam hoc modo compones. Tolle petulam stagni non linitam glutine nec coloratam croco, sed ita simplicem et diligenter politam, et inde cooperies locum, quem ita pingere volueris. Deinde tere colores imponendos diligentissime oleo lini, ac valde tenues trahe eos cum pincello, sicque permitte siccari.

If, however, you wish to hasten your work, take gum which exudes from the cherry or plum tree, and cutting it up very small, place it in an earthenware pot, and pour water upon it abundantly, and place it in the sun, or in winter upon the coals, until the gum has liquefied; and mix it together with a smooth piece of wood. Then strain it through a cloth, and grind the colours with it and lay them on. All colours and their mixtures can be ground and laid on with this kind of oil, except minium and ceruse and carmine, which are ground and laid on with white of egg. Spanish green is not mixed with succus under the gluten, but is laid on by itself with gum gluten. You can otherwise mix it, if you wish it.

CHAPTER XXVIII.

HOW OFTEN THE SAME COLOURS MAY BE LAID ON.

You should apply all colours three times upon wood, whether ground in oil or in gum; and the picture finished and dried and the work carried into the sun, carefully cover it with varnish gluten, and when it begins to flow from the heat, lightly rub it with the hand, and do this three times, and then leave it until it is quite dry.

CHAPTER XXIX.

OF A TRANSPARENT PICTURE.

A PICTURE is likewise made upon wood, which picture is called transparent, and after some it is called aureola, which you compose in this manner. Take tin leaf, not covered with varnish nor coloured with saffron, but simply as it is, and diligently polished, and with it you cover the place on which you wish thus to paint. Then grind the colours to be laid on most carefully with linseed oil, and when very fine, lay them on with a pencil, and so allow them to dry.

CAPUT XXX.

DE MOLENDO AURO IN LIBRIS, ET DE FUNDENDO MOLENDINO.

CUM pertraxeris imagines vel litteras in libris, tolle aurum purum et lima illud minutissime in mundissima pelvi, sive baccina, sicque lavabis illud cum pincello in concha testudinis vel conchilii, quæ de aqua tollitur. Deinde habeas molendinum cum pistillo suo, utraque fusilia ex metallo cupri et stagni ita commixto, ut tres partes sint cupri puri et quarta stagni puri a plumbo. His ita compositis fundatur molendinum ad similitudinem mortarioli, et pistillum ejus circa ferrum quasi nodus, ita ut ferrum inde procedat grossitudine unius digiti, et longitudine modice amplius pedis dimidii; cujus ferri tertia pars infigatur ligno diligenter tornato ad longitudinem quasi unius ulnæ, et rectissime forato, in cujus inferiori parte tamen a fine longitudine quatuor digitorum, sit rotula sive lignea sive plumbea tornatilis, et in media parte superiori figatur corrigia quâ trahi et volvendo retrahi possit. Posthæc mittatur ipsum molendinum in foramen super scamnum ad hoc aptatum inter duas columnellas ligneas in ipso scamno firmiter fixas, super quas sit aliud lignum eis insertum, quod possit ejici et reponi, in cujus medio inferius sit foramen in quo volvatur pistillum molendini. His ita dispositis mittatur aurum diligenter purgatum in molendinum, additâ modicâ aquâ, et imposito pistillo atque superiori ligno coaptato trahatur corrigia et revolvi permittatur, rursumque trahatur et iterum revolvatur, sicque fiat per duas vel per tres horas. Tunc superius lignum ejiciatur, et pistillum in eadem aqua cum pincello lavetur. Deinde molendinum elevetur, et aurum cum aqua usque ad fundum cum pincello moveatur et modice teneatur, donec quod grossius est resideat; moxque aqua in mundissimam baccinam effundatur, et quicquid auri cum aqua exierit, molitum est. Rursumque impositâ aquâ, repositisque pistillo et sursum ligno, iterum

CHAPTER XXX.

OF GRINDING GOLD FOR BOOKS AND OF CASTING THE MILL.

When you have traced out figures or letters in books, take pure gold and file it very finely in a clean cup or small basin, and wash it with a pencil in the shell of a tortoise, or a shell which is taken out of the water. Have then a mill with its pestle, both cast from metal of copper and tin mixed together, so that three parts may be of pure copper, and the fourth of pure tin, free from lead. With this composition the mill is cast in the form of a small mortar, and its pestle round about an iron in the form of a knot, so that the iron may protrude of the thickness of a finger, and in length a little more than half a foot, the third part of which iron is fixed in wood carefully turned, in length about one yard, and pierced very straightly; in the lower part of which, however, of the length of four fingers from the end, must be a revolving wheel, either of wood or of lead, and in the middle of the upper part is fixed a leather strap, by which it can be pulled, and, in revolving, be drawn back. Then this mill is placed in a hollow, upon a bench fitted for it, between two small wooden pillars firmly fixed into the same bench, upon which another piece of wood is to be inserted, which can be taken out and replaced, in the middle of which, at the lower part, is a hole in which the pestle of the mill will revolve. These things thus disposed, the gold, carefully cleansed, is put into the mill, a little water added, and the pestle placed, and the upper piece of wood fitted, the strap is drawn and is permitted to revolve, again pulled and again it revolves, and this must so be done for two or three hours. Then the upper wood is taken off, and the pestle washed in the same water with a pencil. Afterwards the mill is taken up, and the gold, with the water, is stirred to the bottom with the pencil, and is left a little, until the grosser part subsides; the water is presently poured into a very clean basin, and whatever gold comes away with the water is ground. Replacing the water and the pestle, and

molatur eo ordine, quo prius, donec omnino exeat cum aqua. Tali modo molendum est argentum, auricalcum, et cuprum. Sed aurum diligentius est et leniter trahendum, sæpiusque respiciendum quia mollius est ceteris metallis, ne forte adhæreat molendino vel pistillo et conglomeretur. Quod si per negligentiam contigerit, quod conglomeratum est eradatur et ejiciatur, et quod reliquum est usque ad effectum molatur. Quo facto superiorem aquam cum sordibus de baccino effundens; inde aurum diligenter in concham mundam lava. Dehinc infundens ei aquam cum pincello move, et cum per unam horam in manu tenueris ipsam aquam in alteram concham funde, et illud minutissimum quod cum aqua exierit serva. Rursumque impositâ aquâ super carbones calefac et move, ac sicut prius minutum cum aqua ejice, sicque facias donec omnino purgaveris. Posthæc ipsum minutum[1] cum aqua et eodem ordine bis et tertio, quicquid auri susceperis priori admisce. Eodem ordine lavabis argentum, auricalcum et cuprum. Dehinc tolle vesicam piscis, qui vocatur huso, et lavans aquâ tepidâ tertio, incide particulatim, ac in ollam purissimam mittens cum aqua, sine mollificari per noctem, et in crastinum coque super carbones ut non bulliat, donec probes digitis tuis, si adhæreat, et cum fortiter adhæserit, bonum est gluten.

CAPUT XXXI.

QUOMODO AURUM ET ARGENTUM IN LIBRIS PONATUR.

POSTEA tolle minium purum, et adde ei tertiam partem cenobrii, terens super lapidem, cum aqua. Quo diligenter trito, percute clarum ex albugine ovi, in æstate cum aqua, in

[1] "relava," *ex Cod. Guelph.*

wood above being placed, again it is milled in the same way as before, until it altogether comes away with the water. In the like manner are ground silver, brass, and copper. But gold is ground most carefully, and must be lightly milled; and you must often inspect it, because it is softer than the other metals, that it may not adhere to the mill or the pestle, and become heaped together. If through negligence this should happen, that which is conglomerate is scraped together and taken out, and what is left is milled until finished. Which being done, pouring out the upper water with the impurities from the basin, wash the gold carefully in a clean shell. Then pouring the water from it, agitate it with the pencil, and when you have had it in your hand for one hour, pour it into another shell, and keep that very fine part which has come away with the water. Then again, water being placed with it, warm it, and stir it over the fire, and, as before, pour away the fine particles with the water, and you may act thus until you shall have purified it entirely. After this wash with water the same refined part, and in the same manner, a second and a third time, and whatever gold you gather mix with the former. In the same way you will wash silver, brass, and copper. Afterwards take the bladder of a fish which is called huso, and washing it three times in tepid water, cut it into very small pieces, and putting it into a very clean pot with water, leave it to soften a night, and on the morrow warm it on the fire, so that it does not boil up until you prove with your fingers if it adhere, and when it shall adhere strongly, the glue is good.

CHAPTER XXXI.

HOW GOLD AND SILVER ARE LAID IN BOOKS.

Afterwards take pure minium and add to it a third part of cinnabar, grinding it upon a stone with water. Which being carefully ground, beat up the clear of the white of an egg, in

hieme sine aqua, et cum purum fuerit, mitte minium in cornu et infunde clarum, impositoque ligno move modicum, et inde cum pincello imple omnia loca, in quibus aurum velis ponere. Dehinc pone ollulam cum glutine super carbones, et cum liquefactum fuerit, funde in concham auri et lava illud inde. Quod cum effuderis in aliam concham, in qua purgamentum servatur, rursus infunde gluten calidum, et tenens in palma manus sinistræ, move diligenter cum pincello, et pone utrum volueris spissum aut tenue, sic tamen ut glutinis modicum sit, quia si superabundaverit, nigrescit aurum et non recipit fulgorem. Postquam autem siccatum fuerit, polies illud dente vel lapide sanguinario diligenter limata, et polito super tabulam corneam æqualem ac lucidam. Quod si contigerit per negligentiam glutinis non bene cocti, ut aurum in fricando se pulveret, vel præ nimia spissitudine se elevet, habeas penes te clarum vetus sine aqua percussum, et mox cum pincello de eodem modicum ac leniter super aurum liniens, cum siccum fuerit denuo dente vel lapide fricabis. Hoc modo argentum, auricalcum et cuprum in suis locis pones et fricabis.

CAPUT XXXII.

QUOMODO DECORETUR PICTURA LIBRORUM STAGNO ET CROCEO.

SI vero neutrum habueris, et tamen opus tuum quoquomodo decorare volueris, tolle stagnum purum et rasum minutissime, mole et lava sicut aurum, et pone eodem glutine in literis vel aliis locis, quæ volueris auro vel argento ornare, et cum polieris dente, tolle crocum cum quo sericum coloratur, perfundens illum claro sine aqua, et cum per noctem steterit, sequenti die cum pincello cooperies loca, quæ volueris deaurare; cætera habeto loco argenti. Deinde facies subtiles tractus circa literas et folia et nodos ex minio cum penna, et paraturas vestimentorum ac cætera ornamenta.

summer with water, in winter without water, and when it is clear, put the minium into a horn and pour the clear upon it, and stir it a little with a piece of wood put into it, and with a pencil fill up all places with it upon which you wish to lay gold. Then place a little pot with glue over the fire, and when it is liquefied, pour it into the shell of gold and wash it with it. When you have poured which into another shell, in which the purifying is kept, again pour in warm glue, and holding it in the palm of the left hand, stir it carefully with the pencil, and lay it on where you wish thick or thin, so however that there be little glue, because, should it exceed, it blackens the gold and does not receive a polish. But after it has dried, polish it with a tooth or bloodstone carefully filed and polished, upon a smooth and shining horn tablet. But should it happen, through negligence of the glue not being well cooked, that the gold pulverises in rubbing, or rises on account of too great thickness, have near you some old clear of egg beat up without water, and directly with a pencil paint slightly and quickly with it over the gold; when it is dry, again rub it with the tooth or stone. Lay in this manner silver, brass, and copper in their place, and polish them.

CHAPTER XXXII.

HOW A PICTURE IS ORNAMENTED IN BOOKS WITH TIN AND SAFFRON.

But if you have neither of these, and yet wish to decorate your work in some manner, take tin pure and finely scraped; mill it and wash it like gold, and apply it with the same glue, upon letters or other places which you wish to ornament with gold or silver: and when you have polished it with a tooth, take saffron, with which silk is coloured, moistening it with clear of egg without water, and when it has stood a night, on the following day cover with a pencil the places which you wish to gild, the rest holding the place of silver. Then make fine traits round letters and leaves and flourishes from minium, with a pen, also the stuffs of dresses and other ornaments.

CAPUT XXXIII.

DE OMNI GENERE GLUTINIS IN PICTURA AURI.

SI vesicam non habueris, pergamenum vituli spissum eodem modo incide, lava, et coque. Follem quoque anguillæ diligentissime rasum, incisum et lotum eodem modo coque. Ossa quoque capitis lupi piscis loti sicci, diligenter lota in calida aqua ter, ita coque. Qualecunque horum coxeris, adde ei tertiam partem gummi lucidissimi, et modice coque, poterisque servare quamdiu volueris.

CAPUT XXXIV.

QUOMODO COLORES IN LIBRIS TEMPERENTUR.

HIS ita peractis fac temperamentum ex gummi lucidissimo et aqua sicut supra, et tempera omnes colores, excepto viridi, et cerosa, et minio, et carmin. Viride salsum non valet in libro. Viride Hispanicum temperabis vino puro, et si volueris umbras facere, adde modicum sucum gladioli, vel cauli vel porri. Minium et cerosam et carmin temperabis claro. Omnes mixturas colorum, si indigueris ad pingendas imagines, compone in libro ut supra. Omnes colores bis ponendi sunt in libro, in primis tenuissime, deinde spissius; in literis vero semel.

CAPUT XXXV.

DE GENERIBUS ET TEMPERAMENTIS FOLII.

FOLII tria sunt genera, unum rubeum, aliud purpureum, tertium saphireum, quæ sic temperabis. Tolle cineres et cribra eos per pannum, et perfundens eos aquâ frigidâ, fac

CHAPTER XXXIII.

OF EVERY SORT OF GLUE FOR A PICTURE OF GOLD.

If you have not a bladder, cut up thick parchment of vellum in the same manner, wash and cook it. Prepare also the skin of an eel carefully scraped, cut up and washed in the same manner. Prepare thus also the bones of the head of the wolf fish washed and dried, carefully washed in warm water three times. To whichever of these you have prepared, add a third part of very transparent gum, simmer it a little, and you can keep it as long as you wish.

CHAPTER XXXIV.

HOW COLOURS ARE TEMPERED FOR BOOKS.

These things thus accomplished, make a mixture of the clearest gum and water as above, and temper all colours except green and ceruse and minium and carmine. Salt green is worth nothing for books. You will temper Spanish green with pure wine, and if you wish to make shadows, add a little sap of iris or cabbage or leek. You will temper minium and ceruse and carmine with clear of egg. Compose all preparations of colours for a book as above, if you want them for painting figures. All colours are laid on twice in books, at first very thinly, then more thickly; but once for letters.

CHAPTER XXXV.

OF THE KINDS AND THE TEMPERING OF FOLIUM.

There are three kinds of folium, one red, another purple, a third blue, which you will thus temper. Take ashes, and sift them through a cloth, and sprinkling them with cold water,

inde tortulas in similitudinem panis, mittensque eas in ignem, sine donec omnino candescant. Postquam ante diutissime canduerint, et postea friguerint, mitte inde partem in vas fictile, perfundens urinâ, et move ligno. Cumque resederit lucide, perfunde inde rubeum folium, et terens illud modice super lapidem, adde ei quartam partem vivæ calcis, et cum tritum fuerit ac sufficienter perfusum, cola illud per pannum, et trahe cum pincello ubi volueris tenue, deinde spissius. Et si placet similitudinem pallii in pagina facere purpureo folio, eodem temperamento sine calce perfuso, pinge pennâ prius in ipsa pagina nodos vel circulos, et interius aves sive bestias aut folia; et cum siccum fuerit, linies per omnia rubeum folium tenue, deinde spissius, et tertio si sit opus; ac postmodum linies desuper tenue vetus clarum, sine aqua percussum. Purpureum folium et saphireum non teres, sed perfunde eodem temperamento in concha sine calce, et move ligno, et cum per noctem steterit, in crastinum pone quomodocumque volueris linies claro superius. Vestimenta quoque et omnia quæ folio et carmin pinxeris, claro superlinies. Cineres autem coctos, qui remanserint, servare diu poteris siccos.

CAPUT XXXVI.

DE CENOBRIO.

SI desideras cenobrium componere, tolles sulphur, cujus sunt tria genera, album, nigrum et croceum, quod frangens super lapidem siccum, adde ei duas partes vivi argenti, æquo pondere stateræ; et cum diligentius miscueris, mitte in vitream ampullam, cooperiens eam ex omni parte argillâ, et os obstrue, ne fumus exeat, et pone eam ad ignem ut siccetur. Deinde pone eam inter carbones ardentes, et mox cum cœperit calefieri, audies fragorem interius, quomodo se vivum argentum commiscet ardenti sulphuri; et cum sonus cessaverit, statim ejice ampullam et aperiens tolle colorem.

make rolls of them in form of loaves, and placing them in the fire, leave them until they quite glow. After they have first burnt for a very long time and have afterwards cooled, place a portion of them in a vessel of clay, pouring urine upon them and stirring with wood. When it has deposed in a clear manner, pour it upon the red folium, and grinding it slightly upon a stone, add to it a fourth part of quick lime, and when it shall be ground and sufficiently moistened, strain it through a cloth, and paint with a pencil where you wish, thinly, afterwards more thickly. And if you wish to imitate a robe in a page of a book, with purple folium; with the same tempering, without the mixture of lime, paint first with a pen, in the same page, flourishes or circles, and in them birds or beasts, or leaves; and when it is dry, paint red folium over all, thinly, then more thickly, and a third time if necessary; and afterwards paint over it some old clear of egg, beat up without water. Do not grind purple or blue folium, but pour it with the same tempering, without lime, into a shell, and stir it with wood, and when it has stood for a night, the next day use it in what manner you wish, paint over it with clear of egg. Paint over also with glaire of egg, draperies, and all things which you have painted with folium and carmine. You can likewise preserve the burned ashes which remain, for a long time, dry.

CHAPTER XXXVI.

OF CINNABAR.

If you wish to make cinnabar, take sulphur, of which there are three kinds, white, black, and yellow; breaking which upon a dry stone, add to it two parts of quicksilver, in equal weight of the balance, and when you have carefully mixed it, place it in a glass bottle, covering it all over with clay, and close the mouth that the vapour may not exude, and put it near the fire to dry. Then place it among the burning coals, and presently, when it has begun to grow hot, you will hear a noise inside, the manner in which the quicksilver combines with the burning sulphur; and when the sound has ceased, immediately take off the bottle, and opening it, take out the colour.

CAPUT XXXVII.

DE VIRIDI SALSO.

SI autem viridem colorem velis conficere, sume lignum quercinum, quantæ longitudinis et latitudinis volueris, et cava illud in modum scrinii. Deinde tolle cuprum, et fac illud attenuari in laminas, quantæ latitudinis velis, ut tamen longitudo ejus cooperiat latitudinem cavi ligni. Post hæc accipe scutellam plenam salis, et comprimens eum fortiter, mitte in ignem et cooperi carbonibus per noctem, et in crastinum tere eum diligentissime super lapidem siccum. Cumque acceperis surculos graciles, colloca eos in prædictum cavatum lignum, ita ut duæ partes cavi sint inferius, et tertia superius, sicque[1] laminas cupreas ex utraque parte melle puro aspergens desuper sal tritum, collocabis super surculos illos conjunctim, cooperiens diligenter altero ligno ad hoc aptato, ita ut nihil spiraminis exire possit. Post fac foramen terebrari in angulo ipsius ligni per quod possis acetum calefactum aut urinam calidam infundere, ita ut tertia pars ejus impleatur, et mox obstrue foramen. Hoc lignum in tali loco debes ponere, ubi possis illud in sterquilinio totum cooperire. Post quatuor vero septimanas solve operculum, et quicquid super cuprum inveneris, erade et serva, et iterum reponens cooperi ordine quo supra.

CAPUT XXXVIII.

DE VIRIDI HISPANICO.

SI vero viride Hispanicum componere velis, tolle cupri tabulas attenuatas et radens eas diligenter ex utraque parte, perfunde aceto puro et calido absque melle et sale, componesque in minori ligno cavo, ordine quo supra. Post duas septimanas respice ac rade, sicque facies donec color tibi sufficiat.

[1] "linies," *ex MS. Guelph.*

CHAPTER XXXVII.

OF SALT GREEN.

If, however, you wish to make a green colour, take oak wood, as long and as large as you like, and hollow it in the form of a box. Then take copper and thin it into leaves, as broad as you desire, so however that its length may cover the breadth of the hollow wood. After this take a plate full of salt, and pressing it down strongly, cover it with charcoal for a night, and on the morrow grind it carefully upon a dry stone. And when you have taken some slender twigs, place them together in the same hollowed wood, so that two parts of the hollow are below and the third above them, and thus coating the copper plates on both sides with pure honey, sprinkling over them the ground salt, you will fix them, joined together, upon those twigs, covering carefully with another wood fitted for this, so that no vapour can come out. Afterwards make an opening, to be bored in an angle of the same wood, through which you can pour warm vinegar, or hot urine, so as to fill a third part of it, and then close the passage. You should put this wood in such a place that you can wholly cover it with stable dung. After four weeks raise the covering, and scrape off, and keep whatever you find upon the copper, and again replacing it, cover it as above.

CHAPTER XXXVIII.

OF SPANISH GREEN.

If, however, you wish to make Spanish green, take plates of copper thinned, and scraping them carefully on both sides, pour upon them pure and warm vinegar, without honey and salt, and place them together in a smaller hollow piece of wood in the order above. After two weeks examine and scrape it, and do thus until you have colour sufficient.

CAPUT XXXIX.

DE CEROSA ET MINIO.

CEROSAM autem compositurus fac tibi plumbeas tabulas attenuari, et componens eas siccas in cavo ligno sicut cuprum, supra infuso aceto calido sive urinâ cooperi. Deinde post mensem solve cooperculum, et quicquid album fuerit auferens, rursum repone sicut prius. Cumque tibi suffecerit, et minium inde facere placuerit, eamdem cerosam tere super lapidem absque aqua, et deinde mittens in ollas novas duas vel tres, pone super carbones ardentes; habeas autem ferrum gracile curvum, ex una parte[1] aptatum et in summitate latum, cum quo movere ac miscere ipsam cerosam interdum possis; atque hoc tam diu facias donec minium omnino rubeum fiat.

CAPUT XL.

DE INCAUSTO.

INCAUSTUM etiam facturus incide tibi ligna spinarum in Aprili, in Maio, priusquam producant flores aut folia, et congregans inde fasciculos, sine jacere in umbra duas septimanas aut tres aut quatuor, donec aliquantulum exsiccentur. Deinde habeas malleos ligneos cum quibus super aliud lignum durum contundas ipsas spinas, donec corticem omnino evellas, quem statim mittes in dolium aquâ plenum; cumque duo dolia vel tria seu quatuor aut quinque cortice et aquâ repleveris, sine sic stare per octo dies, donec aqua omnem corticis succum in se emordeat. Post hæc mitte ipsam aquam in cacabum mundissimum, vel in lebetem, et supposito igne coque; interdum etiam immitte de ipso cortice in cacabum, ut si quid succi in eo remansit excoquatur. Quam cum modice coxeris, ejice, aliumque rursus immitte. Quo facto residuam

[1] "ligno," *sic Cod Guelph.*

CHAPTER XXXIX.

OF CERUSE AND MINIUM.

But in making ceruse, make for yourself plates of lead thinned, and placing them together dry, in a hollow piece of wood, as the copper, hot vinegar or urine being poured over it, cover it. Then after a month raise the cover, and taking away whatever white there is, again replace it as before. And when you have sufficient, and wish to make minium of it, grind the same ceruse upon a stone without water, and then placing it in two or three new pots, put it upon the hot coals; have also a thin curved iron rod at one end fitted with wood and flat at the top, with which you can sometimes stir and mix this ceruse: and you may do this until the minium becomes quite red.

CHAPTER XL.

OF INK.

To make ink, cut for yourself wood of the thorn trees in April or May, before they produce flowers or leaves, and collecting them in small bundles, allow them to lie in the shade for two, three, or four weeks, until they are somewhat dry. Then have wooden mallets, with which you beat these thorns upon another piece of hard wood, until you peel off the bark everywhere, put which immediately into a barrel full of water; when you have filled two, or three, or four, or five barrels with bark and water, allow them so to stand for eight days, until the water imbibe all the sap of the bark. Afterwards put this water into a very clean pan or into a cauldron, and fire being placed under it, boil it; from time to time also throw into the pan some of this bark, so that, whatever sap may remain in it, may be boiled out. When you have cooked it a little, throw it out and again put in more. Which done, boil down

coque aquam usque ad tertiam partem, sicque ejiciens de ipso cacabo mitte in minorem, et tamdiu coque donec nigrescat atque incipiat densescere, hoc omnino cavens ne aliquod addas aquæ, excepta illa quæ succo mixta est. Cumque videris eam densescere, adde vini puri tertiam partem, et mittens in ollas novas duas vel tres, tamdiu coque donec videas quod in supremo quasi cutem trahat. Dehinc tollens ipsas ollas ab igne pone ad solem donec se nigrum incaustum a rubea fæce purificet. Postea tolle folliculos ex pergameno diligenter consutos et vesicas, et infundens purum incaustum suspende ad solem donec omnino siccetur. Cumque siccum fuerit, tolle inde quotiens volueris et tempera cum vino super carbones, et addens modicum atramenti scribe. Quod si contigerit per negligentiam ut non satis nigrum sit incaustum, accipe frustum grossitudine unius digiti, et ponens in ignem, sine candescere, mox et in incaustum projice.

EXPLICIT LIBER PRIMUS.

the remaining water unto a third part, and then pouring it out of this pan put it into one smaller, and cook it until it grows black and begins to thicken, quite taking care that you add no water, except that which is mixed with the sap. And when you see it thicken, add one third part of pure wine, and putting it into two or three new pots, cook it until you see a sort of skin show itself on the surface. Then taking these pots from the fire, place them in the sun until the black ink purifies itself from the red dregs. Afterwards take small bags of parchment carefully sewn, and bladders, and pouring in the pure ink, suspend them in the sun until all is quite dry. And when dry, take from it as much as you wish and temper it with wine over the fire, and, adding a little vitriol, write. But if it should happen through negligence that your ink be not black enough, take a fragment[1] of the thickness of a finger, and putting it into the fire allow it to glow, and throw it directly into the ink.

[1] " of vitriol, or sulphate of iron; or of black?" see note.—TRANS.

END OF THE FIRST BOOK.

NOTES TO BOOK I.

Auripigmentum, c. 14. The auripigmentum of our author is certainly a sulphuret of arsenic, the ἀῤῥενικὸν and σανδαράκη of Theophrastus[1], the σανδαράκη of Dioscorides[2]. It was the more valued as it approached the colour of gold. Theophrastus, c. 89, tells us that "arsenicon" and "sandarache" are painters' colours.

The native genuine red orpiment, or the sandaracha, was the most esteemed, the Zarnich-Ahmer of the Arabians, the paler kinds being often impure were less valued. "Quod optimum, coloris etiam in auro excellentis."[3]

In the MS. of Eraclius entitled "Liber tertius et prosaicus Eraclii, de Coloribus," &c., contained in the MS. of Le Begue written about the period of the eighth century, and of Byzantine origin, "Auricon," "Auripigmentum," and "Sandaracha" are mentioned, auricon and auripigmentum as produced in Pontus, (near the Euxine,) and the best sandaracha also as produced there, near the river "Ysparin." In article 261, this author tells us how they prepared orpiment for painting: "Break up orpiment in a skin, then grind it with water upon a marble, adding to it a little calcined bone, and again allow it to dry, temper it afterwards with egg for laying upon wood, or on a wall. But upon parchment lay it as you would ceruse. If not good, mix ochre with it, afterwards it is serviceable[4].

The author of the treatise upon colours in the Sloane MS. 1754, British Museum, which is of the fourteenth century, directs the white of egg to be used, also that two parts of orpiment be mixed

[1] Theophrast. Hist. of Stones, C. 89. Hill, Lond. 1746.

[2] Dioscor. Mat. Med. L. 5. C. 76.

[3] Pliny, Nat. Hist. L. 24. C. 18.

[4] Liber Johannis le Begue. MS. Bib. du Roi, Paris, No. 6741. Art. 261.

with one of yolk and calcined bone, then used with the white of the egg.

Orpiment is too valuable a colour to be lost to the artist, and it is quite permanent upon ochres, and when kept from the contact of all other colours. I am in possession of the several modes practised for its use, at a later day, when orpiment was in constant use by the Italian painters, but these are reserved for a future opportunity.

When the yellow sulphuret of arsenic is heated, it parts with a portion of the sulphur, and the substance becomes converted into red orpiment, or "Realgar."

Cennino mentions the two colours; "Oropimento," the yellow, and "Risigallo," the red sulphuret, or Realgar[1].

Cerosa, c. 1. The fabrication of that colour which the Greeks called ψιμύθιον, psimuthion, and the Romans Cerusa, or psimythin, is described by Theophrastus[2], Dioscorides[3], Vitruvius[4] and Pliny[5] in nearly the same terms, and they speak of it as a colour commonly used in painting. Theophrastus thus describes the process. "To make which, lead is placed in earthen vessels over sharp vinegar, and after it has acquired some thickness of a kind of rust, which it commonly does in about ten days, they open the vessels and scrape it off, as it were, in a kind of impurity; they then replace (the lead) over the vinegar, repeating often the same method of scraping, till it is wholly dissolved, they then beat what has been scraped off into powder, and boil for a long time, and what at last subsides to the bottom of the vessel is the psimuthion."

Pliny describes the process nearly in the same terms.

Dioscorides adds that the principal manufactories of ceruse were at Rhodes, at Corinth, at Lacedemon and Pozzuoli.

Vitruvius informs us that the Rhodians put vine twigs, or tendrils, in barrels, into which they poured vinegar, over this were suspended sheets of lead and the barrels were closed up. After a certain time the lead was found changed into ceruse, and Pliny states that the Rhodian ceruse was the most esteemed,—"Laudatissimum in Rhodo." Would the decomposition of these

[1] Cennino Cennini. Trattato della Pittura. Tambroni, Roma, 1821. CC. 47 and 48.

[2] Theophrast. Hist. of Stones. C. 101.

[3] Diosc. Mat. Med. L. 5. C. 103.

[4] Vitruv. Archit. L. 7. C. 12.

[5] Pl. Nat. Hist. L. 34. C. 18.

tendrils facilitate the formation of carbonic acid, and thus account for the superiority of the Rhodian ceruse? Marble is now used for a like purpose in Holland.

The Byzantine MS. published by Muratori[1], and which he refers to the eighth century, gives the same receipt for making "white lead," "De compositioⁿ psimitthin."

Thus, no alteration in the manufacture of white lead had been attempted from the time of Aristotle to that of our author. L. 1. c. 39. In the MS. British Museum, Sloane 1754, ceruse is called "Minium Album." This MS. is of the early half of the fourteenth century[2].

The use of ceruse as a pigment is confined by Theophilus to plaster work, wood, or canvass. Sir H. Davy in his analysis of the colours of the ancients[3] found that the whites he examined "were all fine chalk," yet, that Davy did not find white lead used upon a mural decoration is no proof that it did not enter into the other decorations, or pictures, of the Romans, used in encaustic, or with gums, gluten, or oil upon plaster work.

The white lead of the present period is a combination of protoxide of lead with carbonic acid, and is a sub-carbonate of lead. It is prepared, at Clichy, by forming a precipitate, with carbonic acid gas, in a saturated solution of prot-oxide of lead in distilled vinegar. The current of carbonic acid gas is passed through this solution, and the precipitate is washed and dried.

A patent was recently taken in London for a means of manufacturing white lead by one process from the metal. Very small shot was violently agitated in water, by which a pulverulent hydrated oxide was produced. This, having been exposed to the air, became converted into a carbonate.

Had this powder been exposed to the action of carbonic acid gas in a close chamber, a fine carbonate of lead would have been produced fit for the artist; as it was, the patent was not much valued, as two processes would have been necessary during the manufacture.

Cenobrium, c. 1. We are informed by Theophrastus that two kinds of cinnabar (κιννάβαρι) were known to the Greeks, the one

[1] Muratori, Antiquitates Ital. medii ævi. V. 2. p. 370.

[2] MS. Sloan. 1754. Cod. Memb. B. Museum. "Liber de Coloribus Illuminatorum sive Pictorum." Fourteenth century.

[3] Works of Sir H. Davy. L. 1840. V. 6. p. 131.

native, the other factitious[1]. The native, which was found in Spain, was hard and stony, as was also that brought from Colchis. The factitious (which does not appear to be a cinnabar) came from Ephesus in the form of a sand, shining like scarlet, which was ground and washed. Hill in his notes to Theophrastus[2] thinks that this latter substance was the "Sil Atticum" of the Romans, injudiciously confounded, he states, by Vitruvius with the Ochra Attica of the ancients. Hill, however, produces no reason or support for this assertion. The "Sil Atticum," was of a golden colour, which was altered in its hue by burning. The origin of the term is probably σίλας, fulgor, auro similis.

There were the "Sil Atticum," Marmorosum, and Pressum, vel Syricum.

The factitious cinnabar was more likely a true minium, the invention or introduction of Callias the Athenian. (See Minium.)

The "Native Cinnabar," however, of Theophrastus was identical with ours, it was vermilion, or sulphuret of quicksilver, and that writer relates the process of extracting the metal from the ore by "rubbing it with vinegar with a brass pestle in a brass mortar."[3] During this process the brass would be attacked by the acid, and, through the affinity of the copper for the sulphur, the cinnabar would be reduced to the metallic state.

Dioscorides tells that "a cinnabar is worked in Spain[4], and that during the operation the workmen cover the face with a skin because of the (mercurial) vapours dangerous to inhale;" he likewise describes the process of extracting quicksilver from cinnabar.

Pliny, likewise, describes a "Cinnabar or Minium" "whose produce we have called quicksilver," "cujus vomicam argentum vivum appellavimus."[5]

Cinnabar was the "Minium" of Vitruvius, who gives a process for using it in staining walls of a red colour[6].

Cinnabar has been confounded with the "Miltos" of the Greeks, which is a red ochreous earth and the most ancient red colour known. (See Sinopis; also Ezekiel, c. 23, v. 14.)

[1] Theophrast. Hist. of Stones. C. 103.
[2] Id. by John Hill, Lond. 1746, p. 135.
[3] Id. C. 105.
[4] Dioscor. Mat. Med. L. 5. C. 63.
[5] Plin. Nat. Hist. L. 33. C. 7.
[6] Vitruv. de Archit. L. 7. C. 9.

Petrus, of St. Audemar[1], gives the method of making the best vermilion, " Vermiculum optimum." " If you wish to make the best vermilion, take a glass bottle and cover it with a lute outside; and take one part of quicksilver, by weight, and two, by weight, of white or yellow coloured sulphur. Put it into the above bottle, which you afterwards place on four stones, and, laying a very slight fire of coals round the bottle, cover its mouth with a tile, and when you see the smoke come white from the mouth of the bottle, close it, but when a smoke as red as the vermilion shall come out, take it from the fire and you will have the best vermilion." Similar recipes are found amongst the medical writers of the thirteenth and fourteenth century, but are mostly repetitions.

The Greeks called " Dragon's Blood," κιννάβαρι Ἰνδικον, Indian cinnabar.

Exudra or Exedra. ἴζησα or ἰζοῦσα, the aorist tense of Ζῶ, vivo, may perhaps be the origin of this word. From Ζῶ is ἐξίχῶ, to protrude or " être en saillant." The exudra of Theophilus is a dark colour intended to relieve and finish the flesh, in the artist's language " to bring it out."

" Exedra is a colour from a mixture of red and a little black for making the flesh colour, otherwise called cedra."[2]

Flavus Color, c. 1. Theophilus here describes the process followed in his time for making the "Cerussa usta" of the ancients, and the "Massicot" or "Minium" of the moderns, according to the duration of the heat employed.

Flavus color is made of burnt ceruse. *Tab. Voc. Sin. Le Begue.*

This colour was also called " Arxica " or " Arsicon " by the Byzantines. Arsicon or arxica is like orpiment; it is a yellow colour, and by being mixed with the sap of the plant called scaldalussa, a green is made; and the sap of other plants is good for this. *Id.*

There is no doubt that the " Arxica " of Cennino Cennini is massicot, or a prot-oxide of lead. " Giallo è un colore, che si chiama arzica,"[3] &c. There is a yellow colour which is called "arzica," which colour is the *produce of chemistry*, and is little used. He adds, " this colour is very delicate, loses its force in the air, is not good

[1] MS. 6741. Bib. du Roi, Paris. Art. 174. Le Begue.

[2] Tabula de Vocabulis Synonymis, &c. MS. Le Begue. Paris.

[3] Trattato della pittura. Tambroni. Roma, 1821. C. 50.

upon a wall, but is proper in a picture. By mixing a little German blue and giallorino (Naples yellow) with it, it forms a fine green." He tells us that it is used by "portrait painters," "á miniatori." The term "*archimiato*" must have been overlooked by the Cavaliere Tambroni, in his note upon this chapter, when he refers the arxica of Cennini to the gommagotta (gamboge) of the present day. Cennini uses the same term in describing minium; "Rosso è un colore, che si chiama minio, il quale è artificiato *per*[1] *archimia.*" Cennino does not otherwise speak of massicot, which was much in use, both before and after his time, in Italy.

The Spanish[2] and Portuguese[3] writers, who appear to have retained the ancient terms for a long time, call the prot-oxides of lead by the name of "azarcon" and "zarquaon."

In the Tab. Voc. Syn. of Le Begue, arxica is also defined to be "a yellow earth, fit for painting with, and likewise useful in making moulds for casting copper." This must have been an ochreous earth.

During the combustion of lead in the preparation of minium, the yellow prot-oxide of lead is produced; this is separated from the lead by washing and trituration. The massicot, suspended in the water, is drawn off. This having after a time settled, is collected and dried, and is the massicot of the moderns.

Massicot is a useful colour in oil painting if used alone.

Folium, c. 14. In the *Tab. Voc. Synon.* Folium is thus described. "Folium is used for dying cloths and is a red colour, and another kind is purple, and another is blue. There is another variety which is made by mixing, with the same red colour, ashes, or the lixivium of ashes of elm wood, and it is called folium stampnense, or stanniivense."

The term Folium appears to include the vegetable reds and red purples of the Byzantine Greeks; to these may be added the vegetable blue colours.

Theophilus does not inform us from what substance his folium was composed, merely that "folium is of three kinds, one red, another purple, the third blue."

The author or copyist of the treatise "De coloribus Illumina-

[1] Trattato della pittura. Tambroni. Roma, 1821. C. 41.

[2] Carducho. Dialogos de la Pintura. Madrid, 1633. Dialogo Octavo, p. 132. Also Francisco Pacheco. Arte de la Pintura. Seville, 1649. L. 3, pp. 387, 390, and 404.

[3] Nunez. Arte da Pintura. Lisb. 1615. 4to, p. 67.

torum sive Pictorum,"[1] and which treatise is of Greek origin, informs us that "Morella quædam herba est in terra Sancti Egidii. Ex hac herba tria grana in semine exeunt. Et exhiis granis telæ tinguntur, sicque murum colorem reddunt qui color 'folium' dicitur." Morella is a certain plant in the country of St. Giles (Athens). And from this plant three grains proceed in the seed. From these grains cloths are dyed and thus render a mulberry colour, which colour is called folium.

I give an extract from a MS. belonging to the "Bibliothèque Royale at Montpellier," of the early part of the fifteenth century, kindly lent to me for inspection by M. Libri of the Sorbonne, with permission to make any extracts relating to the arts. This MS. belonged to Cardinal Alberti, and is a collection of medical recipes, &c. It contains a notice upon the materials and processes used in the arts, which appears to be drawn from the Byzantine source; it is entitled, "Liber diversarium artium." I give the extract upon folium. "De natura et distemperatione 'folii' seu 'morellæ.'" "Quædam herba est in terrâ Sancti Œgidii, ex hac herbâ tria grana in semine exeunt, sicque mirum colorem reddunt, qui color folium dicunt, qui color sic distemperatur. Pannum folii scindes et fissura in coquilla pones, postea sic fundes claram ovi et sine maturescere, et fit purpureus. Distempera folium urinâ, temperatâ cum aquâ tepidâ, vel cum lexiviâ per noctem unam; deinde projicietur et distemperatur cum claro recenti; adhibe modicum calcis. Confectio folium; in frusta nimis tenuia et modica incidatur; et glutine casei preparato, distemperatur; et sic permittatur donec bene permixtum sit."

"Of the nature and tempering of 'folium,' or 'mulberry colour.'" "It is a certain plant in the country of St. Giles, from this plant in seed three grains proceed, and so yield a beautiful colour, which colour they call 'folium,' and which is thus tempered. You cut up the cloth of folium, (dyed with folium,) and place the shreds in a small vessel, afterwards you pour the white of egg over it and leave it to mature, and a purple is made. Temper folium with urine, mixed with warm water, or with a lixivium, during one night; it is then poured out and tempered with fresh glaire (of egg); put a little lime to it. A preparation of folium; it is cut up into pieces, very thin and small, and is tempered with prepared glue of cheese; and it is thus left until it has well mixed together."

[1] MS. Sloan. 1754.

Peter of St. Audemar writes of folium, "De folio quomodo distemperatur." "Purpureus color quem folium vocant laici, qui lanam inde tingunt, vel potius Anglici, in quorum terra conficitur, 'nuormam' vocant, non uno semper modo distemperatur. Nam aliqui cum urina, vel lexivia de cinere fraxinii facta, ut in parietibus præcipuè, alii in pergamenis cum visco de caseo, ita facto." This identifies the *folium* of St. Audemar with our "madder," which was called "norma, nuorma or gorma," in Celtic. This allusion to our country at so early a period is not a little curious in the history of the arts. The action of the acid or alkaline substances with which these vegetable purples or blues were mixed would of course influence their colour.

The "morella," was a species of "solanum" bearing a dark berry or seed. The turnsol was used for making a violet colour, the fruit of the mulberry tree, the elderberry, the petals of the violet and many vegetable colours which must have been very little permanent even in illuminated books.

Varantia, Warancia, Warantz or Garance, our Madder, was likewise employed by the ancients.

Dioscorides uses the same term for madder which the Greeks of the present day employ, ἐρυθρόδανον. The "rubia tinctorum" of the Romans and the rubia major of the mediæval chemists, in order to distinguish it from the rubia minor, or bugloss, of the alkanet, or anchusa species.

The "Hysginum" of Vitruvius, which has been confounded by his commentators[1] with vaccinium (violet) and hyacinthum, (dark purple,) is the "alga tinctoria" or "lichen rocella" of the moderns, the 'orseille' of the French." Hysginum from ὕσγη, is without doubt the ποντιον φῦκος of Theophrastus[2], who tells us that it grows under the rocks in the Island of Crete, and that it is used to dye cloth purple. Pliny[3] tells us the same thing; the same author identifies the purple of hysginum with that of Pozzuoli[4]. "Quare *Puteolanum* potius laudatur quam Tyrium, aut Gætulicum, vel Laconicum, unde pretiosissimæ purpuræ: *causa est, quod hysgino maximè inficitur rubiamque cogitur sorbere.*" "But that from Pozzuoli is more esteemed than the Tyrian, or Gætulian, or Laconian, whence come the dearest purples: the cause is that a thing

[1] De Laet. Vitruv. Amst. 1649. Philander, Hermolaus.

[2] Theophrastus, Hist. Plantarum. L. IV. C. 7.

[3] Pliny, Hist. Nat. L. 26. C. 10. L. 32. C. 6.

[4] Idem. L. 35. C. 6.

is most powerfully dyed with hysginum and it is thought that the red endures." "The painters (he continues) lay a ground with red ochre, then glazing over the purple with egg, they give the splendour of minium." Pliny here uses *sandyx*, for burnt ochre, and *minium* for red lead. "If they wish rather to make a purple colour, they underlay blue, then they overlay the *purpurissimum* with egg."

Xenophon, Cyr. viii. 3. 7, writes ὑσγινοβᾶφὴς, dyed purple.

Sir H. Davy states[1] that a pale rose colour was found in a vase in the Baths of Titus, that the colouring matter was vegetable, and that it was mixed with a considerable quantity of carbonate of lime, (chalk.) He proceeds, "It differed from madder, as the madder lake gave a much deeper tint to muriatic acid and produced a tawny hue when its weak muriatic solution was acted on by muriate of iron. The ancient lake did not change its colour. The ancient lake agreed with the lake of cochineal in being rendered of a deeper hue by weak alkalies, and of a brighter hue by weak acids, but it differed from it in being much more easily destroyed by strong acids. It agreed with both in being immediately destroyed by a solution of chlorine."

Was this colour "orcéine?" (the colouring matter of the "lichen roccella" and the hysginum of the ancients.) If so, this valuable colour seen by Davy, and which astonished all who saw it, should not be neglected.

In the Tab. Voc. Syn. we find, "Purple, which is a red colour, is otherwise called 'folium;' and the English, in whose country it is grown, call it 'wormam.' A purple colour is also made from the stone, *sil*, burnt, and extinguished in vinegar while it is glowing. Oster is a fish, of the sea or elsewhere, from which a purple colour is made, or from its blood; and also the sea conchæ, when cut, make a purple colour. And likewise white chalk tinctured with madder, (*rubeâ radicê*). So also the herb called vaccinium yields a purple colour if mixed with lake," (cum lacte[2].) This leads us to the consideration of the lake of the ancients.

"Lacca is a kind of gum made of the red liquor which proceeds from the juice of the ivy cleaving to and creeping upon trees, if its branches are perforated with a sharp instrument in the month of March:"[3] again,

"Edera is a plant, creeping, by attaching itself to trees, which in

[1] Davy's Works, v. 6, p. 131, et seq.

[2] pro "lacca."—TRANS.

[3] Tab. Voc. Syn. MS. Le Begue.

the Gallic is called "'yene,' and 'herre,' the branches of which being perforated or cut half through below, in the month of March, give out a red liquor which, boiled with urine, is 'lake,' with which the skins of swine are stained:" and again,

"Gum lacha of the ivy is made from the juice or liquor flowing in March from the boughs of the ivy plant, cleaving and growing to the trees, if cut with a sharp instrument." This will be noticed more fully in notes to lib. 3.

The lacca of Cennini is doubtless our "gum-lac," yet the gum-lacha of the Greeks was more properly so called, being a true gum not a resinous substance.

Another vegetable purple red, which will come under the head "Folium," was made from the "Bresilium Lignum."

"Braxilium vel Brexilium est lignum rubeum, a quo cum pistus, roseus sit, in lixivio forti, vel urinâ, cum albumine commiscetur, exit color roseus vel purpureus."—Tab. Voc. Syn.

That Brazil or Bresil wood was in use at an early period for a purple or rose coloured dye we have abundant evidence. Moses speaks of "rams' skins dyed red,"[1] אלגר algom, ζύλον ἀκίνθινον, the Brasile tree, according to Holyoke. This word has been rendered in a French version of the Testament, "jaune" as if from "adom" à "adamah," terra, and therefore judged to mean "*yellow ochre.*"

The word Brasilium is probably derived from the Greek Βράζω.

The Pseudo Santalum, vulgo "Saunders wood," from which the red colour was obtained, is a native of the East. Huet[2] states that "Sampian wood, which is the same as Brasil, comes from the East Indies." It doubtless found its way into Egypt by the Red Sea, and thus became known to Moses, who could have taught us much relating to the arts of the Egyptians.

Thus, contrary to the received opinion, the country Brazil has taken from rather than given the name, to the wood which it yielded of so fine quality and in such quantity.

Chaucer mentions Brasil wood before the discovery of the New World.

> "He loketh as a sparhauk with his eyen;
> Him nedeth not his colour for to dien,
> With Brasil, ne with grain of Portingale."
>
> THE MANCIPLE'S PROLOGUE.

"The "grain of Portingale" was the "Grana Tinctoria, the

[1] Exodus, c. 25, v. 5.

[2] Huet, Memoirs of the Dutch Trade, p. 171. Lond. 1722.

"κοκκος" of the Greeks, the "Kermes berries." These are excrescences of the ilex "cocciglandifera," "quercus coccifera" or scarlet oak, and were supposed to be a berry. The Greeks used them as a red dye. The coccinos and vaccinium of the Byzantines was from this kermes, as also the cremisi of the Italians, cramoisi, French, and our crimson; the "scharlatto" of the Italians, our scarlet.

The "yellow Saunders" wood which yielded the red colour called "Brixilium" by the Latins and "Verzino" by the early Italian artists, is the Romaic "κοκκίνοκωλος."

Madder likewise was a folium of the Byzantines. "Rubea radix" est, de quâ rubeus color fit miscendo cum cretâ albâ, id est gypso."—Tab. Voc. Syn.

This was the "Verantia" or "Alithina" of the Byzantines, the "true red," τὰ ἀληθινὰ βάπτει, Myrepsus [1].

St. Audemar speaks of madder as "Warrantia" in the Le Begue MS. Art. 183.

I give a recipe from a MS. of the fourteenth century which will show the means employed to extract the colour from madder in our country at that time.

For to make a fyne rede. Take woode-ashys and seeth them in clere water awhile, as hot as you might soffer thyne hand, then cast there in madyr and the white of an eg and bole 6 worthe thereto, and hit will be as rede as scarlet. And for to make more, suffyceth, take comyn ashys and unguant them and make lye thereof, then temper with water as thou wilt have it thynner or thyckker [2].

Neither Eraclius nor Cennini speak of madder. The MS. from Mount Athos gives directions for making a vegetable red only from kermes [3].

GUMMI FORNIS, quod Romanè Glassa dicitur, cc. 21 et 22.

My reason for not concurring in the opinion of Merrimée and the French writers, that copal was the resin intended by Theophilus, was a conviction, subsequently verified by comparison and experiment, that copal would neither answer to the description given, nor to the treatment proposed by Theophilus in the composition of his varnish.

At the conclusion of Merrimée's [4] chapter upon copal varnish

[1] Salmasius ad Capitolini, Macrinum, p. 169.

[2] MS. Sloan. 122. Tractat. Var. de Medicinal, p. 56.

[3] Manuel D'Iconographie Chrétienne. Didron, Paris, 1845.

[4] Art of oil painting. Merrimée, translated by Taylor, pp. 69 and 70.

and the varnish of Theophilus, the writer is seen combating with his error: he evades the text, supposes mistake in the given quantity and imperfect description as to the mode of making the varnish, questioning the intentions of his author, in order to render his own idea tenable.

The followers of Raspe, who see the Latin "Glessum" and "Amber," in the word, "glassa," are still more liable to the same physical objections; it would be found impossible to dissolve any portion of amber by strictly adhering to the directions given by Theophilus in c. 21, and it is indispensably required that a proposed resin strictly fulfils this condition.

On reading our author, the description given of the resin employed is clear: "et adde gummi (Arabici, Cod. R.) quod vocatur fornis, minutissime tritum, quod habet speciem lucidissimi thuris, sed cum frangitur fulgorem clariorem reddit." It is impossible that Theophilus, "presbyter et monachus," and therefore necessarily familiarly acquainted with "Thus," or "Frankincense," as used for incense, could compare with it any resin but one which closely resembled it in outward appearance; in such a case of comparison, the clear and concise writing of Theophilus, upon all the practical subjects on which he treats, absolves him from carelessness, and even did the question rest upon this comparative evidence alone, copal or amber are entirely out of the question, neither possessing points of appearance in common with "Thus."

It was therefore necessary in the first place, in order to determine the gum resin of Theophilus, to fix upon one which bore a strong external resemblance to "Thus." The fine specimens of the Arabic sandarac, which exactly resemble the choice "Thus," viz. the T. masculinum, corticosum, and feminœum of the ancients, pointed out that resin, for it has the distinguishing mark, a bright glassy fracture, which the Thus has not; or, as Theophilus writes, "sed, cum frangitur, fulgorem clariorem reddit."

But the term "fornis" which is given to the resin will still more strongly designate Sandarach, if it can be shown that this name has been applied to that gum resin.

In the second process given by Theophilus for making the "Gluten Vernition," he calls the same gum fornis "Glassa," "supra dictum gummi fornis, quod Romanè glassa dicitur," ("*aliter Arabicum,*" an interpolation in the Cod. Royal, Paris.)

If it can also be shown that this term was likewise used to de-

note sandarac, the problem is solved and the composition of the varnish in use at this early period of the arts made evident.

Tacitus shows that the word "Glas," given by the Germans to amber on account of its transparency, has been Latinized.

Tacitus, *de Germanicis, c.* 45, writes of amber, "quod ipsi Glessum vocant," and elsewhere—"Quod Germani glas vocant," probably, "a similitudine vitri:" and doubtless the same comparative nomenclature would be used for other species of transparent resins, the word having once become Latinized [1].

Some Greek and Arab authors, consequently, many of the mediæval writers, have confounded the Amber, Sandarac and Juniper resins together; the two latter are, even at this day, often mistaken for each other, or indiscriminately noticed.

Serapio, de temperamentis [2], c. 266, p. 163, writes, on the authority of Galen, "De Karabe vel Ka-krabe," "Haur Romi, id est Karabe;" and of Dioscorides, "Et dicitur quod gummi haur Romi, quod nascitur juxta fluvium quod dicitur Rhodanum, quod distillatur in flumine illo, congelatur ibi," &c., &c.; and of Paulus Agineta, "Karabe est gummi arboris haur Romi, emanat ab haur Romi, et congelatur, et est coloris auri: putant quidam, quod istud Karabe sit sandaracha et dicunt, quod Karabe Sodoniæ est hujusmodi gummi: et est gummi funeris; eo quod Latini ponebant ipsum super corpora defunctorum."

Isaac Eben Amram tells us, "Sandaracha est gummi citrini coloris similis Karabe, sed non est ita durum sicut Karabe, et est in eo parum amaritudinis, et affertur a terris Christianorum, et virtus ejus est similis virtuti Karabe, &c.; et qui accipitur ex sandaracha et oleo rosarum et limitur cum eis, confert scissuris quæ fiunt in membris, &c. et si non reperitur, pone loco ejus pondus tertiæ partis plus pondere ipsius de Karabe: quod quidem, dixit Galenus, esse gummi 'Haur Romanæ.'" This writer, by the phrase "et affertur a terris Christianorum," seems to indicate the gum resin of the European Cedrus Juniperus; as also does Paulus by "Karâbe Sodoniæ," a species of this tree growing in Phœ-

[1] I am fortified in this presumption by a passage in Aldrovandus, "Musæi Metallici." Lib. 3. C. 18. "Latini succinum. Germani veteres, ut Tacitus et Plinius referunt, glessum vocabant quæ vox hodie vitrum significare videtur; *cum aliqua species succini, instar vitri pelluceat, unde postea ortum est proverbium in aliquod micans et nitidum, Electro lucidius.*"

[2] Serapio. Fol. Venice, 1550. Abrahamo Judæo, et Symoni Janseni, interpretibus.

nicia and the islands of the Mediterranean and the Archipelago; probably also thence its name of "Haur Romana," for Andrea Alpagus, in his "Liber Arabicorum Nominum," tells us that, "Harrire, id est Juniperus," and Rulandus, "Lex. Alchim." that "Hara, i. e. Juniperus." [1]

The following will show that the comparative term, "glassa," has been applied to sandarac, as glessum or glass to amber, probably for the same reason, "a similitudine vitri." "Glassa est genus vernicis." Rulandus, Lex. Alchem. "Glassa est genus vernicis." Johnson, Lex. Med. "Glassa est genus vernicis siccioris." Castelli, Lex. Chym. "Vernice est vernix *guttosa*." Johnson, Lex. M. "Sandarax, id est vernix gummi." Serapio, c. 57.

But the word "fornis," the firniss, vulgo furniss, of the Germans, is a direct name for the same resin, from the Latin vernix.

Parr. Dic. Med. gives the derivation of the Arab word sandarac, saghad-narak, *gummy;* and this author calls the cedrus gummi "vernix" 'quia verno tempore fluat,' because it flows in the spring season.

Ruland has shown that the word "fernis" has been Latinized as well as "glas," "porro quia resina illa juniperi sandarax, et vernix dicitur apud Arabes, unus error alterum traxit. Quidam indocti mox factitiunt hoc, quod vocamus vernis (*oder vernisch*) quo utuntur pictores, et alii artifices, quod fit ex oleo et gummi, habuere pro vera sandaracha metallica, ut si scriberes, ℞ sandaracæ," illi intellexerunt, secundum 'Arabes,' ℞ gummi vel resinam juniperi, aut '*fernicem*' illum factitium," &c.

The Paris MS. contains the addition of the word "*Arabicum*" "glassa vocatur, aliter Arabicum." This manuscript is of the fifteenth century, and this interpolation is a proof that the "Arabic sandarac" was understood as the "*fornis*" by the copyist.

Pliny[2] "De picis generibus et resinis" mentions "Arabica resina," and in so doing gives a good description of sandarac. "Arabica resina alba est, acri odore, difficile coquenti." The acidulous pungent smell yielded by this resin when melted is peculiar to it, and it is one of the most difficult of the resins to unite

[1] The black poplar was also called "Haur Romana," and Martial calls the "gum" of the "black poplar" "succina gemma." Ep. lib. 4, 32, another confusion.

[2] Pliny. Nat. Hist. L. 14. C. 20.

with oil: Pliny concludes his notice of the resins by the statement that every resin is dissolved in oil. "Resina omnis dissolvitur in oleo;" the word "coquenti" is thus explained.

Sandarac was called "sandaracha Arabum," during the middle ages, by most of the writers on physics; one example will suffice. Caneparius "de atramentis"[1] writes, "De vernice, qua effinguntur coria aurata. Cape oleum lini ad pondus librarum trium, *vernicis*, vulgo appellatur *sandaracha Arabum*, libra una," &c., &c. Andrea Alpagus[2] calls sandarac "sanderos," and adds "est almedon, et est vernix quæ dicitur sandaracha."

In a manuscript belonging to the Royal Library at Montpellier, of the early part of the fifteenth century, and which is principally a collection of authors upon medical subjects, is a small treatise upon the arts. This MS. was kindly placed at my disposal by M. Libri, of the Sorbonne, Paris[3].

From this MS. I give some extracts which will show what the "fornis" or "glassa" was.

[4] "INCIPIT LIBER DIVERSARUM ARTIUM.

"De glutine vernicon.

"Pone oleum lini in ollam novam parvam, adde gummi quod vocatur fernix vel grassa, minutissime tritum, et assimilatur thuri: deinde ponatur ad lentum ignem et coquatur, ita ut non bulliat, usque dum tertia pars consumatur, omnino et caveatur ab igne, quod multum periculosum est, et de levi non extinguitur."

"Ad vernicem.

"Accipe glassa, vel fernix grana, estque idem quod vernix, et fac eam lente liquare, et bullito oleo linosæ, insimul misce, commixtum ita tractu, dimitte bene coopertum donec frigescat."

It will be seen that these are, in substance, the two chapters of our author, that the "fernix," "grassa," "glassa," and "vernix" are synonymous, and explain Theophilus. "Grassa" is the Moorish and a Spanish term for sandarac: the substitution of the *r* for *l*, is common also with the Neapolitan and Roman people.

[1] Petrus M. Caneparius de atramentis, p. 333.

[2] Alpagus. Liber Arabicorum nominum.

[3] This MS. formerly belonged to Cardinal Alberti, Rome.

[4] This word appears to be Greek, *βερνίκι*, varnish, *βερνίκωμα*, varnish work, *βερνικώνω*, to varnish.

Therefore, fernis or vernix is a direct and primitive term for sandarac; and, secondly, glassa is a comparative term for the same resin.

Tingry, in his work on varnishes [1], states that juniper and sandarac resins are still called "*verniz*" by the Germans, so that another proof of the German origin of Theophilus may be adduced.

Lessing, founding his opinion upon the derivation which the Bollandists [2] gave to the German "firniss," saw that word in the "fornis" of Theophilus, thus strongly corroborating the last assertion.

I have elsewhere given extracts from the MS. published by Muratori in which the word "gumma" implies sandarac. See note, Oleum.

Peter of St. Audemar [3] gives several recipes for the manufacture of varnish for metallic leaves.

"Oleum de lini semine et pice uno pondere mixtum, et eamdem mensuram de 'vernix' pone in ollam et fac bullire bene. Deinde mitte folia stanni bene verniciata, intus, et postmodum siccata ad solem." (Qu. vernicia intus et sicca, &c.)

"Linseed oil and resin being mixed in equal weight, and the same measure of 'vernix,' place them in a pot and boil them well. Then place the leaves of tin, well varnished, inside, and afterwards dried in the sun." (Qu. inside, varnish well and dry afterwards, &c.)

Again,—

"Oleum lineum et medianam corticem nigri pruni mitte in ollam novam ac fac bene bullire super carbones vel claro igne paulatim. Deinde munda, 'glassam tuam' quantum volueris in pondere et pone in alteram ollam, et aluminis quasi mediam partem et sanguinis draconis, et omnia hæc mitte in ollam, et ad ultimum mixtum, picem adjunge et bene funde, et quam citius hæc omnia fundentur appone supradictum oleum, et secundum unctionem confectionis, et sine bene bullire simul, et sæpe move, et post modum mitiges ungulam tuam et temptabis utrum bonum sit an non."

In a third recipe "white thus" and resin are used instead of glassa, with linseed or hempseed oil, "oleum de lino vel de canapo."

Michelino de Vesucio of Venice, whom Le Begue describes as one of the best painters in the world, "Michelino de Vesucio,

[1] Acta SS. April, T. 2, p. 302.

[2] Vom Alter der Oelmalerey, 1739. Ouvres de Lessing, 1839, T. 9. p. 482.

[3] Eraclius de Artibus Romanorum. MS. 6741. Bib. du Roi, Paris. Liber 3. Art. 207. MS. Le Begue.

pictore excellentissimo inter omnes pictores mundi," gave this composition to be used in the preparation of "ultramarine," and speaks first of "vernice liquida," with which resin and gum mastic are to be united. This was in 1410.

John Le Begue himself gives the preparation of a "vernix liquide pour paintres." The process is the same as that in the second recipe of Theophilus. But Le Begue directs, "Take aromatic glassa which is dull outside, and when broken it is clear and shining inside, like glass." "Prenez glasse aromatique qui est obscur par dehors, et par dedans, quand on le brise, il est clere et luisant à maniere de verre." With this, oil of linseed or hempseed, or walnuts is to be used, two parts to one of resin. He concludes, "Et l'etendez desus la peinture a vos doigts, car si vous le fassiez du pincel, il seroit trop epais et ne pourroit secher."

Having established that the vernix is sandarac, the "vernice liquida" of Cennino, and of the early Italians, is known to us. Mrs. Merrifield in her translation of this author[1] refers in a note to this fact. Cennino, therefore, gives the receipt for making the "vernice liquida" in the 151 cap. He singularly also shows that the Italians were aware of the action of metallic oxides as driers. The directions are for making a mordant, perfect for walls, pictures, upon glass, or iron, or anywhere.

"Take your oil, cooked at the firè, or in the sun, by the mode which I have before shown you. Grind with this oil a little white and verdigris; and when you have ground them as with water, put a little vernice into it and allow all to boil together a little."

It appears to me that this passage has never been rightly read, the word "vernice," by which Cennino intended sandarac, having been accepted as "varnish" or the "vernice liquida" itself. The white (carbonate of lead) and verdigrise, carbonate of copper, acting as driers. Van Eyck could not have therefore invented "driers" for the oils or varnishes used for pigments more than he did the use of these materials themselves. It is my endeavour here to ascertain and expose the materials universally employed in the studio previously to the time of Van Eyck. What that painter probably did invent, I have endeavoured to show in the Preface to this work.

Cennino speaks of "vernice liquida" in several places, yet he gives no mode of making it unaccompanied by driers.

[1] Cennino Cennini, translated by Mrs. Merrifield.

But in a MS. in the Sloane[1] collection of the early part of the fifteenth century, written in the Venetian dialect, are several curious recipes for varnishes, colours, &c. The whole appears the collection of an Englishman, and in it are several notes bearing dates which determine its age. A date in page 125 of the MS. is as early as "1424, 12th June;" also, "1454, 11 Fefraro io mi parti a Bologna, vā a Millano;" "a di 15 a di 3 de Marzo, va astare a Novaria cum Maestro Baldasaro;" "1455, a di 18 de Giognio va astare cum Maestro, &c."

In p. 61, is the date, "furst daj of Louly°, 1456," written in an English hand, probably by the collector of the contents.

This MS. is therefore of the period of Cennino, who finished the composition of his work on the 31st July, 1437, and is of importance, as being the result of the knowledge and experience of a chemist of the period, which class were called in, as were the "pigmentarii" of the Romans[2], to the councils of the studio. I intend to publish this MS., and give merely an extract or two relating to the varnishes of the period.

"A FARE VERNICE LIQUIDA.

"To. vernice salda ℔j; olio dī semente di lino ℔ 3; pece Grega ℔ 3; sarà bona da invernicare balestre.

"Take vernix, whole, ℔ 1; linseed oil, ℔ 3; Greek pitch (common white pine resin from which the oil has been evaporated over hot water) 3 ℔. It will be good for varnishing crossbows."

"A FARE VERNICE DA DI PINTURI.

"Toy olio de lino quanto voy e mitilo al fuoco e falo tanto coxere che quando li meti una pena che incrostigi i pili como se ardesse e quando è coto levalo dal fuoco, e getali vernice pista e sedaçata (qu. 'stacciata,') a poco a poco nel dito olio, e tieni mente di non meterne tropo per volta perche se la varebe alta e gonfiarebe per modo che trabucarebe, e quando ai dato tuta la vernice, remitela uno poco al fuoco tanto che si riscaldi un poco, e poy levalo dal fuoco e colala con la stamegna e sic fata.

"Nota che al medesimo modo la poy fare dando al dito olio pece Greca tanto che sia le due parte de cio che fu l'olio.

[1] Sloane, No. 416.

[2] The physicians and apothecaries of Rome were classed as, pigmentarii, seplasiarii pharmacopolæ, medicamentarii, &c.

"El terzo modo la poy fare dando al dito olio quando è coto tanta raxa quanto fo l'olio, e questo è secondo Nicolao di Bertoldo."

"TO MAKE PAINTERS' VARNISH.

"Take the quantity you please of linseed oil, place it on the fire and boil it until upon putting a pen into the boiling oil it warps as if burnt; and when it is cooked, take it from the fire, and cast pounded and sifted vernix into the said oil, little by little, and remember not to put too much at a time, because it will rise up and swell so as to run over. And when you have put in all the vernix, replace it for a short time upon the fire until it has become slightly hot again, then strain it and it is done.

"Note—that the best manner to make it is, by putting to the said oil, Greek pitch, two parts as much of the resin as there is oil. And a third way of making it is by putting to the same oil, when cooked, as much resin as there is oil, and this is according to Nicolao di Bertoldo."

The use of these materials in our own country has been traced by Walpole to a very early date. On the 2nd of August, 1239, A.D. (23 Henry III.,) Odo and his son were paid "for oil, varnish and colours bought and pictures made in the Queen's Chamber at Westminster."

The Rev. Mr. Bentham has noticed in the Archæologia, v. 9, varnish among the materials used for painting the cathedral of Ely. In the Sacrist's annual roll of expenses from Michaelmas (8th of Ed. III. A.D. 1335,) to Michaelmas following, under the title of "custos novis operis" and of "nova pictura."

"Item, in 20 ℔. de vernyz, Empt. pro eodem, *5s.* prec. lib. *3d.*"

In the Sacrist's roll from Michaelmas 1341 to the Michaelmas following, under the head "Minute expenses" is this:—

"In 6 lib. de albo vernish 18*d.* prec. lib. *3d.*
In 27½ lagenis olei empt. *2s. 2d.*"

In the roll from Michaelmas 1346 to Michaelmas 1347.

"In 7 lib. de vernyz empt. 21*d.*"

Mr. Smith[1] has given an account of the contents of the Rolls in the Exchequer, which prove the use of oil and varnish during the painting of the chapel of St. Stephen at Westminster, the date of the earliest roll being 20th of Edward I. A.D. 1292.

Oil, red and white varnish and "tinctu" (probably oil of turpentine) are here mentioned.

[1] Antiq. West.

Edward III. destroyed this chapel, and, in rebuilding it with increased magnificence, pressed all the painters for this work in Kent, Middlesex, Essex, Surrey and Sussex; also, by another edict, those in the counties of Lincoln, Northampton, Oxford, Warwick, Leicester, Cambridge, Huntingdon, Norfolk and Suffolk[1].

Among the items of expenses in the Exchequer Rolls for this work, are—

"Four flaggons of painter's oil for painting the chapel, 16*s*.
Half a pound of Tynct. for the same.
Six pounds and a half of white varnish from 'Lomyn de Bruges,' at 9*d*. per pound, for painting of the said chapel."

In an old English Monkish MS. of the fourteenth century, (Sloane 2584,) in a collection of recipes for painting and the materials required, a curious varnish is given.

"Take of Terbentyne 1 ℔., of gume Arabyk 1 ℔., of frank ensence 1 ℔., and melt them togeder, and put there to oyle of Lynsed als a mochel as it nedes: and thus you schalt assay zif it be wele molten to geder. Take a drope or 2 of clere water and sprinkle therein, and then take a litel there of be twene your fingers and zif it is helding togeder, als wer gumed, it is goode, and zif it is nost so put yet more oyle."

Arabic resin, or Sandarac, has been called "Gum Arabic" indiscriminately with the gum of the Mimosa Nilotica, even as late as the middle of the last century. This has led to strange mistakes. The author of "Institutes of Experimental Chemistry," who should have therefore known better, comments upon the singularity of the *fact*, that "Gum Arabick" is soluble in fixed oil, and states that it yields an oil by distillation[2].

That the "vernice liquida" of the Italians during the fifteenth and sixteenth centuries was identical with the varnish of Theophilus we have proof amongst their writers. Cardanus, who flourished at the commencement of the sixteenth century, and who therefore possessed the experience of the fifteenth, tells us that "liquida vernix" is made from linseed oil and vernix of the cedar juniper species.—De Plautis, Lib. 8.

"Vernix ex cedro Juniperi species."

"Ob id ignitur e 'sicca vernice,' et lini oleo fit liquida vernix,

[1] Rymer's Fœdera. T. 5, p. 670.

[2] In 2 Vols. London, 1759. V. 2, p. 91 and 92.—Dossie.

ad omnes cœli impetus coercandos aptissima, unde picturis addi solet."

Caneparius, "De Atramentis," p. 300, writes—

"Ex Vernice, (Sandaracha Arabum,) et oleo ex semine lini, fit liquida vernix."

The two processes given by Theophilus would form, owing to the peculiar nature of the resin, two different varnishes. By the first process the resinous portion alone of this gum resin would be dissolved, unless the boiling were continued for a very long time, so as at last to raise the heat to a high degree, in order to keep the oil at the *simmering* point, which becomes higher in proportion to the loss of the more volatile portions of the oil, which it will be remembered are allowed to escape, "until a third part is consumed." The varnish, however, is not perfected by the first process, and is of a very dark colour. By the second process the whole of the resin may be incorporated with the oil at once and the long boiling is not required, nor does Theophilus prescribe it. The word "bullire," is used by our author in opposition to "coquere," the latter having the signification of "to seeth," the former "to boil violently," as "æstuo" "ferveo," against the danger of which he cautions the artist.

The true Arabian sandarac is stated by Schousboe[1], a Danish traveller, to be produced by the thuia articulata, which is a cypress. It is called "el grassa." The juniper cypress does not grow in Africa. Dr. Ure gives an analysis of this gum-resin. "Spec. gr. 1.05 to 1.09. It contains three resins, one soluble in alcohol, somewhat resembling pinic acid or turpentine resin, one not soluble in that liquid, and a third soluble only in alcohol of 90 per cent."

The following are taken from the MS. from Mount Athos. These varnishes are of the twelfth century.

"VARNISH OF PESERI.

"Take Pesēri which you have baked in the sun, one hundred drachmas, and white resin, seventy-five drachmas. Place them in a pot upon a fire, so as to melt and combine these two substances together. Filter, and employ this varnish in exposing it to the

[1] Nicholson's Journal, Vol. 4, p. 369. Taken from the Danish Journal, "Biblioth. de Physique."

sun. Pay attention to apply the first couch as thin as possible, to avoid blisters. If the mixture is too thick and difficult to spread, add naphtha, or pesēri not baked; by this means you will obtain a liquid varnish. If you have a great quantity of mastic, take fifty drachmas of resin and twenty-five of mastic: this mixture will give you a very good and brilliant varnish."

"ANOTHER VARNISH OF SANDALOZE.

"Take one hundred drachms of Sandaloze, grind them upon a marble, or in a mortar, into very fine powder. Place this powder in a pot, with a little naphtha, and a little pesēri, to prevent burning or blackening in the melting. Place the vase over hot coals and cover it with a plate: uncover often to stir it with a stick until all is well melted. When melted and a foam is formed, take the vase from the fire, and add half an ocque[1] of pesēri baked in the sun, and heated beforehand. Then filter through a fine cloth, and you will keep this varnish in a vase; if it grows too hard, add naphtha, which will permit you to spread it easily without forming blisters.

Sandalus or Sandaloz is the Persian word for Sandarach.

INCAUSTUM, c. 40. The use of ink is ancient; Moses mentions it in Numbers, v. 23, also Jeremiah, xxxvi. 18; the principal colouring matter was smoke black combined with tannic acid. These inks approach the composition of the Chinese or Indian ink as made at present; the Chinese have had the credit of the invention of ink, but it is more probably of Egyptian origin.

Coloured inks were used by the Orientals; the emperors of the East had their "sacrum encaustum," which was made with purple[2] and which was kept in vases of gold enriched with gems, the guardianship of which was entrusted to the royal officers[3], and the use of which was interdicted as a capital offence.

The word "encaustum" is evidently in this case much perverted from its original signification, it having been first used to denote the process of the ancient Greek painters, who applied heat to their colours, which were laid upon an absorbent surface with wax, in order to drive them into the grounds upon which they

[1] The ocque is a weight used in the Levant, equal to about three pounds and a half, English weight.

[2] Nouveau traité de Diplomatique, T. 1, p. 554. (Note by Le Comte de L'Escalopier, idem.)

[3] Du Cange, Gloss, vide Caniclinus.

were superposed. The term was retained while the process changed, and hence the different coloured fluids used for painting or writing, and which were, in either case, laid on with pencils, were still called "encausta."[1] The word "atramentum" has been similarly perverted. Originally representing a dark colour or fluid, it gradually was used to denote different coloured fluids or "inks" used for various purposes[2].

The fabrication of ink by means of "Roman vitriol" (sulphate of iron) and oak bark, (tannic acid,) is of more recent origin, probably a century or two before the Christian era.

Sir H. Davy, "on the Papyri in the Museum of Naples," writes—"I looked in vain amongst the MSS. and in the animal charcoal surrounding them for vestiges of letters in oxide of iron, and it would seem from these circumstances, as well as from the omission of any mention of such a substance by Pliny, that the Romans, up to his period, never used the ink of galls and iron for writing. And it is very probable that the adoption of this ink and the use of parchment took place at the same time; for the ink composed of charcoal and a solution of glue can scarcely be made to adhere to the skin, whereas the free acid of the chemical ink partly dissolves the gelatine of the MS., and the whole substance adheres as a mordant."[3]

This is not certain; Pliny gives a mode for detecting sulphate of iron in sulphate of copper by the infusion of galls upon paper; he says "it instantly blackens."[4]

Davy appears to have overlooked the following passage in Pliny, which shows that acid inks were known before his time. "Omne autem atramentum sole perficitur, librarium gummi, tectorium glutino admixto. Quod autem aceto liquefactum est, ægre eluitur."[5]

Atramentum is mentioned by Theophilus towards the close of this chapter. Whether the "atramentum librarium" of Dioscorides, composed of three ounces of soot with one ounce of gum, (see Dioscor. v. 183, Περὶ μέλανος,) was intended, or the sulphate of iron, green vitriol, "atramentum tectorium" of the Romans, is open to

[1] Cicero, de natura deor. II. 20. Pers. III. 11.

[2] Caneparius de Atramentis.

[3] Sir H. Davy's Works, Lond. 1840. V. 6, p. 174.

[4] Pliny, Nat. Hist. L. 34. C. 11. "Deprehenditur et papyro, galla prius macerata; nigrescit enim statim ærugine illita."

[5] Pl. Nat. Hist. L. 35. C. 6.

conjecture. M. de L'Escalopier prefers the former hypothesis, as he has translated the word "atramentum" into "noir"—black; it will be seen that I have preferred the latter in the presence of the bark juice, or tannic acid.

Another atramentum, the "atramentum sutorium" of the Romans, or "sulphate of copper," blue vitriol, is certainly not intended.

INDICUM, c. 14. Both Vitruvius and Pliny[1] mention indigo; "when divided it is black, but diluted it yields an admirable mixture of purple and blue." Indicum was called by the Byzantine artists, and others, "Azoreum Romanum." In a MS. of the fourteenth century of Byzantine source[2] we find "Roman azure, otherwise indigo, is ground in water. In this Roman azure you can mix orpiment for a yellow green. Likewise, if you add Brasil, it will be a purple."

In the same MS. the azures are defined.

"Azorium bonum est quod Saraceni faciunt. Item, azorium Romanum est aliud quod Indicum vocatur."

John Archerius, who in A.D. 1398[3] wrote a treatise upon colours from the verbal directions of Jacobus Cona, a Flemish painter then residing in Paris, calls indigo "Bagadellus." This is the "indacobaccadeo" of Cennino.

The tariffs of Marseilles speak of the indigos of Bagdad, which are called "indigo bagadel," since the year 1228[4].

The introduction of indigo into western Europe gradually put an end to the culture of the *isatis tinctoria*, pastel, or woad, which was at one time so lucrative a branch of industry."[5]

IN LAQUEARI, c. 14. In our author this word means the ornamenting of ceiling or plaster work. Theophilus distinguishes it from "in muro," as by caustic lime being employed in the latter, it is rendered unfit for the reception of certain colours which "in laqueari" can be applied.

The Catholicon tells us that "Laquear" is so called from the

[1] Hist. Nat. L. 33. C. 13. Et id. L. 35. C. 6.

[2] Sloane MS. 1754. British Museum.

[3] MS. Le Begue. Paris.

[4] M. Depping, Hist. du commerce entre le Levant et l'Europe, T. 1. p. 141. Note by le Comte de l'Escalopier. Theoph. Par. 1843.

[5] Weigelb. Geschichte der Erfendengen. Hist. of Inventions, &c.,

conjunction of the reeds at the top of the habitation (or temple). Or "Laquearia" are what are laid over the beams and are interwoven with those beams. Also laquearia are those works which cover and ornament apartments; hence Josephus in VIII°, "De lignis celatis, opere laqueario, auroque vestitis."

Thus, from originally denoting the interwoven wood, reed, or plaster work, the word became applied to the ornaments with which that work was covered, and in such sense it is used by Theophilus.

St. Isidore, L. xix. c. 12, Originum; thus refers to laquearia. "Laquearia sunt quæ cameram subtegunt et ornunt, quæ et lacunaria dicuntur: quod lacus quosdam quadratos vel rotundos ligno vel gipso vel coloribus habeat pictos, cum signis intermicantibus."

Jeremiah, c. 22, v. 14. "Et facit laquearia cedrina, pingitque synopide," "and it is *ceiled* with cedar and painted with *sinoper*," (translated *vermilion* in the English version.)

Pliny tells us that Pamphilus, the master of Apelles, instituted the custom of painting "lacunaria" or the intervals between beams or arches upon walls, and adds "nec cameras ante eum taliter adornari mos fuit."

Lazur, c. 14. The Lazur of Theophilus is doubtless the male cyanus of the Greeks, the deep blue lapis armenus, the Kuanos, κυανὸς, of Theophrastus, which has, as yet, been confounded with the lapis lazuli, or Greek σάπφειρος.

Theophrastus mentions among the valuable stones "σάπφειρον," "Sapphire," which is of a dark dye[1], and not very different from the male cyanus "κυανοῦς." This comparison, Hill remarks, "is a confirmation that the sapphire and cyanus are not the same stone, as they are compared together;" it may be added that it identifies the sapphire with the lapis lazuli, the cyanus being of two kinds, divided into male and female, the male being of a deeper colour[2]. Yet Hill here unfortunately falls into error, as he remarks that "this cyanus is a gem, and is the lapis lazuli of which ultramarine is made," whereas that colour is only truly made from the sapphire of the Greeks, the true "lapis lazuli." Theophrastus does not speak of cyanus "as a gem" at all; noticing that in the "carnelian" and the "lapis lyncurius"

[1] Theophr. de Lapidibus. C. 65. Hill.
[2] Idem, p. 83. C. 56. Id.

gems are divided into male and female; he instances the "cyanus," of which he is not then treating, as being divided in the same manner. Hill continues the error of previous commentators, Philander, De Laet., C. Leonardus, &c., &c., &c.

Theophrastus tells us that the sapphire was spotted, as it were, with gold, "χρυσόπαρος." Hill denies this to be the lapis lazuli, following De Boot, who writes, "Quam gemman Plinius sapphirum vocat, cyanus est, seu lapis lazuli," a double error, divided between both the critics.

But Theophrastus says that[1] "The native cyanus," (or lapis armenus) "κυανὸς αὐτοφυὴς" has in it "chrysocolla," "χρυσοκόλλαν," which, with the ancients, was a green oxide of copper. Hill here admits this to mean the lapis armenus, attempting to avoid the dilemma by making the cyanus before mentioned a "gem," forgetting that there were more than one kind of "cyanus."

In c. 90, Theophrastus places κύανος, cyanus, and "chrysocolla" among colours used by painters.

Hill, having apparently perplexed himself, accuses Pliny of confusion[2], and, having embroiled the question, asserts that Pliny has misunderstood Theophrastus. This is both unlikely and erroneous. Pliny "De Jaspidum generibus" l. 37. c. 9, describes cyanus, and after mentioning, as Theophrastus, that the Egyptian kind was "tinctured," proceeds, "Dividitur autem et hoc in mares fœminasque. Inest ei aliquando et aureus pulvis, *non qualis in sapphirinis.*" He follows with "SAPPHIRUS ENIM ET AUREIS PUNCTIS COLLUCET. "Ceruleæ et sapphiri, raroque cum purpura. *Optime* apud Medos, nusquam tamen perlucidæ," &c., certainly a distinction is made here between the cyanus and the sapphirus.

The deep blue, "lapis armenus" or cyanus, is even now cut for ornaments; some of this so closely resembles sapphirus or lapis lazuli that it is only by the test of fire, which destroys the blue colour of the native carbonate of copper, the two are to be distinguished. De Boot[3], upon lapis lazuli, gives this true test of the stone. "Fixus lapis lazuli, hoc est, qui igni impositus colorem non mutat."

"The lapis lazuli is permanent, that which is placed in the fire does not change colour, this is the legitimate proof; it is mostly

[1] Theophr. de Lapidibus, p. 101. C. 70. Hill.
[2] Theophr. by Hill, p. 131.
[3] De Boot, Gemmarum et lapidum historia. Leyden, 1647. C. 119.

brought from the East. That found in Germany is not permanent, it is commonly called 'LASURSTEIN,' and this is the mean between the Armenian stone, which is friable, and the lapis lazuli, which is equal in hardness."

Theophrastus, c. 71, speaks of a sandy cyanus, the "bergblau" of the Germans, our mountain blue.

The "Lasur-stein" or male cyanus, the deep blue lapis armenus, is most probably the "Lazur" of Theophilus.

The Persian "Lazoard" blue, is probably the origin of the term "Lazur." Beckmann states that the Persians are very fond of ultramarine, but that Persia only produces the blue copper ore, (the male cyanus,) and that the real lapis lazuli is found in the mountains of Tartary in Bucharia, extending eastward from the Caspian[1].

Most of the mediæval writers have confounded the lapis lazuli, the lapis armenus, blue jasper coloured with carbonates and arseniates of copper, mountain blue, the one with the other, and errors have arisen which even now are to be dispelled.

But there were factitious blues used by the ancients in painting. Theophrastus tells us that "the Egyptian Kuanos was factitious, and that the historians think worthy of a place in their annals, the king of Egypt who was the inventor of the artificial cyanus."[2] It was the wrong translation of the second sentence in this chapter by Hill, which led to his confusion and his wrongful denunciation of Pliny. "There are three kinds of Cyanus," Hill has translated "there are three kinds of *this*," which he thus makes relative to the "factitious" Egyptian kind just before mentioned. Pliny avoids this error, yet mentions, like Theophrastus, all the kinds together. The "Cærulea" of Pliny are all factitious kinds[3], which Sir H. Davy thinks preparations of blue carbonates and arseniates of copper."[4] Vitruvius, however, gives the composition of the Egyptian blue. "Arena cum natri (*or* nitri) flore conteritur, adeo subtiliter ut efficiatur quemadmodum farina, et æri Cyprio limis," &c.; the different MSS. have both "natri" and "nitri." Thus sand, carbonate of soda, to form the glass, and the colouring matter copper filings, were the component parts of

[1] Beckmann's Inventions. L. 1814. V. 2, p. 315.

[2] Theoph. C. 98.

[3] Pl. Nat. Hist. L. 33. C. 13.

[4] Davy's Works, v. 6, p. 131.

the Alexandrian blue, afterwards made at Pozzuoli and used, Davy tells us, in the Baths of Titus and in the Aldobrandine marriage. These azures had not changed at all. In an excavation made at Pompeii, at which Davy was present, a small vase was found filled with a pale blue colour, which Davy asserts was "a mixture of lime and Alexandrian frit."

Other azure colours were made by the Greek artists for the purpose of painting and illuminating.

Azurium or "lazurium" is the colour otherwise called "celestis or celestinus," otherwise "blancus," otherwise "Persus," and elsewhere "ethereus." Tab. Voc. Syn.

In a collection of medical and other recipes at the end of the MS. of Theophilus, and which have not been written later than the commencement of the thirteenth century, I find two very curious modes of making "azurium," the first of which is made from silver, and is, I confess, to me, incomprehensible, as an oxide of silver would be the result of the process instead of a blue colour. The second is from copper. I give the text for the curious.

"SI VIS FACERE AZURIUM OPTIMUM.

"Accipe ollam novam et mitte in eas laminas purissimi argenti quantas volueris, et pone illam ollam in vindemiam quæ est projecta de torculari sive de tina, et cooperi ollam cum laminis de ipsa vindemia et serva diligenter usque ad xv. dies, et sic aperies ollam illam, et siccata quod est in laminis, rade in mundissimo vase. Quod si amplius volueris fac iterum similiter."

"SI VIS ALIUM AZURIUM FACERE.

"Accipe ampullam de purissimo cupro et imple fortissimo aceto, et cooperi diligenter os ejus, ne aliquid humoris vel vaporis possit exire, et addens si necesse est ad hoc, tenacem terram vel pastam, et ipsam ampullam ita clausam pone in aliquo calido loco aut in terram aut in fœnum projectum de stabulo et sic dimitte per unum mensem et tunc aperi illam ampullam et quod inveneris in ea dimitte ad solem siccare."

This last recipe would form an oxide of copper, which by the continued action of the acid would become a sub-acetate; this, decomposed by lime, would yield verditer.

These recipes are found frequently among the notices upon colours of the Byzantine school, the silver being used alone, but

the copper being directed to be used with sal ammoniac and wine lees, by Dionisius[1], and with lime and vinegar by Petrus de St· Audemar[2], thus procuring a verditer.

Geber[3], in his notice of silver, tells us that, "exposed to the contact of acid vapours and of sal ammoniac, it takes a beautiful violet colour." Any colour, however, procured from silver, on account of its liability to suffer from hydro-sulphurous vapours, would be very little permanent. Pure silver, however, will not take this colour under such circumstances.

Limbus, c. 16. In the Synonyma Magistri Johannis de Garlandia, written in the eleventh century, the word Limbus is described as meaning the ornament upon the border of a garment. In C. 60. L. 3, Theophilus directs that the names of the Apostles be inscribed on the limbos or borders surmounting the figures —" Quorum nomina scribes in limbo." The Greek artists wrote the name of the personage represented either on the nimbus or glory, or on the limbus surrounding it, as the Greeks were forbidden to reverence unknown images.

Manisc, c. 14. In the table of synonimes " Menesch," is stated to be a red colour darker than minium and lighter than sinoper; the hue of indigo is likewise attributed to it. The juice from the berries of the elder was also called " Menesch," " Succus est color trahens ad indicum. Alii dicunt esse rubeum, minus clarum quam minium et magis clarum quam sinopis; et aliter vocatur menesch quod aliter dicitur ipse menesch esse succus sambuci." *Idem.* Theophilus calls the drapery made with " succus folii " " Violaticum."

The word Menesch is Greek, the Romaic " Μενεξές" signifying " violet colour ; " from this word probably the Turkish " menewiche," purple colour, has arisen. That a violet colour would coincide with the directions for the use of manisc by Theophilus is evident, for it is used mixed either with folium, or a little black and red, as a ground for a drapery, manisc and lazur, and, lastly, pure lazur being used to lighten it. It is likewise used in conjunction with orpiment as a ground, upon which more orpiment is used as a middle tint and pure orpiment as a high light; the violet colour would most effectually neutralize the pure yellow of the

[1] MS. Le Begue, 6741. Paris, Art. 5, 29.
[2] Id. Art. 169, 170.
[3] Geberi de Alchimia, lib. III. fol. 1529.

orpiment. Again, in the imitation of the rainbow, c. 16, manisc, as a violet colour, is conjoined with cinnabar and with yellow, both of which it would carry out; in the same chapter directions are given to shade manisc with folium, a little black being added at the extremity. It is evident that it is a tender colour, as veneda is directed to be first laid on if used upon walls, and the word appears to imply that class of colours possessing a violet tint rather than indicative of any particular substance. I have found receipts for the manufacture of a bluish or violet colour from the petals of the violet flower, which would be little permanent, and which has probably, as woad, disappeared after the introduction of indigo.

Minium, c. 14. It is remarkable that although Theophrastus has accurately described the miltos and cinnabar of the Greeks, he has made no mention of minium or the "red oxide of lead."

A great confusion of terms has unfortunately occurred amongst the ancient writers with respect to minium, and numerous errors have arisen from the reproduction of these inaccuracies. The minium of the Romans was sometimes our "vermilion," or "sulphuret of mercury," sometimes our "minium," or "protoxide of lead," sometimes the "red ochres," as the "minium sinopium" of Pliny.

Dioscorides[1] signalises this error. "Some erroneously believe that minium is identical with cinnabar," &c. The minium of Dioscorides was produced from a galena. "For[2] minium is made from an argentiferous stone mixed with sand." Was this the "artificial cinnabar" of Theophrastus invented by Callias the Athenian in the reign of Praxibulus, only ninety years before his time[3]? This would account for the confusion of terms.

The "minium" manufactured from cerussa is called "sandyx" by Dioscorides, L. 5, c. 57. This term for minium was adopted afterwards in Italy, as Hieron. Cardanus says that minium was also called "sandyx," and that "sandix" was a term also applied to burnt ochre; and in the much quoted line of Virgil,

"Sponte suâ sandyx pascentes vestiet agnos,"

This latter colour would seem to be intended, rather than

[1] Dioscor. L. v. C. 63.

[2] Idem.

[3] Theophr., λίθων βίβλίον, ρδ'. Hist. of Stones, c. 104.

"red arsenic" or "red lead." See also Cæsalpinus, de Metallis, L. 3, c. 14. Hodie sandycem, id est Cerussam ustam quousque ut rubentem acquiescerit, vulgo minium vocant.

The minium of Vitruvius is a cinnabar. For in his chapter on "The consideration of Minium,"[1] he says, "Foditur gleba, quæ anthrax dicitur" "emittit lachrymas argenti vivi." Anthrax was a term applied by the Greeks to gems or rare stones of a red colour; Vitruvius evidently applies it to the native cinnabar, as "it yields drops of quicksilver." He calls the minium of the moderns, or red prot-oxide of lead, "sandaracha."[2] "Cerussa vero cum in fornace coquitur, mutato colore ad ignis incendium efficitur sandaracha."

But Pliny, better informed upon these points, tells us that a minium is made from a veined stone, from which also silver is extracted, not from that whose liquid we call quicksilver;" galena is evidently intended, as it is by Dioscorides[3]. Yet he tells us that minium is called cinnabar by the Greeks, "and that a minium called also cinnabaris is produced in the mines of Spain," as at this day.

An inferior minium, the "minium secundarium" of Pliny, was made by grinding the burnt and exhausted lead ore, of a red colour.

In a chamber in the Baths of Titus a bright red was found in an earthen vase. This was analysed by Davy, who found that it fused into litharge, consequently that it was the true "minium" or red prot-oxide of lead[4].

When massicot is calcined in a reverberatory furnace, it gradually assumes a dark purple colour; when this has taken place, the doors should be closed, allowing the air to enter very slowly. The longer the process of cooling the finer is the minium, and the colour is heightened if it is kept constantly stirred, as more oxygen is imbibed. The quantity of oxygen taken up by the lead is enormous. I have been assured by a practical chemist, that twelve parts of lead, by weight, produce thirteen of minium, if the process has been properly conducted.

I give an extract verbatim from the MSS. of Peter of St. Aude-

[1] Vit. de Archit. L. 7, C. 8.
[2] Idem. L. 7, C. 12.
[3] Pliny. Nat. Hist. L. 33, C. 7, De Minio.
[4] Davy's Works, Lond. 1840. Vol. 6, p. 131.

mar, and collected by John Le Begue. It will show that the By zantines at a later period also called minium "sandaracha."[1]

"Nisi fallor, minium, id est sandaracam, et album plumbum, id est cerusa, unius naturæ sunt. Si in ignem mittes cerusam, nomen et colorem et fortitudinem accipit, quia quanto plus ustum fuerit plus rubet, et quanto minus ustum plus pristinum colorem retinet, id est, alborem aut pallorem; et ponendo ipsum in maceris, teritur cum aqua gummata, nunquam vero cum ovo. In pergamenis vero poni potest, cum ovo distemperatum. Sed in lignis cum oleo."

Muro Recenti, c. 2. Emeric David[2] is in error when he affirms that Theophilus gives directions for painting in "fresco." The blunder of supposing all paintings, executed upon a wall, that were not accomplished with an oily vehicle, has been lately remarked elsewhere.

Theophilus mentions painting upon wall, "in muro," and upon ceiling or plaster work, "in laqueari." In the former style particular colours are to be used, mixed with lime to make them bind, "propter firmitatem," chap. 16. The dry wall, "murus siccus," is saturated with water, and the colours applied while it is wet. The whole dries together, c. 15. This was the Byzantine mode of painting upon walls, "in humido," and is quite a different process from that known by the name of "fresco," which was of Italian invention. When dry and firm, these paintings received glazings of the rarer colours upon them, mixed with egg, or other glarea.

Muro, quomodo pingitur in, c. 15. I have remarked elsewhere that Emeric David is in error when he states that Theophilus gives directions for painting in fresco. Theophilus nowhere instructs us in the art of fresco painting, properly so called and so understood by the Italians at a later period, and by us as "fresco buono," or true fresco. Although painting upon walls was much in use during the latter period of the Roman empire[3] and was employed in every possible place by the early Christians in the decoration of their temples, and lime was used with the first colours laid upon the well moistened wall for permanency, "prop-

[1] MS. John Le Begue. Bib. du Roi, Paris, No. 6741. Art. 176.
[2] Emeric David. Discours historique sur la peinture. Paris, 1812.
[3] Pliny. L. 35.

ter firmitatem," and the colours allowed to dry with the wall itself, that they might *adhere*, " ut hæreant," yet this process, as it will be seen by consulting the fifteenth chapter of our author, was widely different from the Italian invention of a later date, by which the colours *unite* with the new plaster of lime and sand and are fixed upon the surface, yet forming part of the body of the cement itself. Theophilus speaks of lime, only in connection with mural decoration.

Requeno[1] thought with reason that the ancients were ignorant of the style of "buon fresco," and that the directions of Vitruvius[2] " De tectoriis operibus" were for colouring the surface of the plaster before it hardened. He adds that Winkelmann and the academicians observed that at Herculaneum, when some of the paintings were washed, the colours of the figures, &c., were removed and the even smooth *coloured ground* only remained. Other figures were painted with " Punic wax and oil." Vitruvius certainly nowhere speaks of *painting* upon cement, although he gives directions for *colouring* it.

The passage of Pliny[3] " Ex omnibus coloribus cretulam amant udoque *illini* recusant, purpurissimum, Indicum, cæruleum, melinum, auripigmentum, appianum, cerussa," applies to the process described by Vitruvius.

The phrase, however, of Theophilus " in recenti muro" " upon a new wall" cannot be overlooked. It is not the "murus siccus" of chap. 15, but it appears to mean that "fresco" was intended by Theophilus. How then to coincide the neglect of our author in this instance with his universal care in description, if " fresco" were intended? Theophilus, who promises to teach us all the Greeks knew in the art of painting, would not, certainly, have neglected so important a branch. The Byzantine MS. published by Muratori is silent upon the subject, Eraclius likewise, as also the writers collected by Le Begue; and it was not until the translation of the Byzantine MS. from Mount Athos, published by Mons. Didron[4], appeared, that any light was thrown upon it; Theophilus, although he has spoken generally, has neglected nothing.

I give a translation of the chapters relating to " painting upon walls" from this MS., as well as an interesting note by M. Didron,

[1] Saggi sul ristabilimento dell' Antica Arte, &c. L. 1, pp. 187, et seq.

[2] Vitruvius de Archit. L. 7. C. 11.

[3] Pliny. L. 35. C. 7.

[4] Manuel d'Iconographie Chrétienne. Didron et Durand. Paris.

placed at the end of the first book, which shows that the Greeks at this hour follow the process of the twelfth century, and which, although not "true fresco" as at present understood, is a transition from the mural practice of Theophilus, and probably the "recens murus," to the "fresco buono," and perhaps a better style for interiors than either, as offering the same facility to the artist as the former and being as durable as the latter style. See the ideas of Guevara[1] upon this subject.

"MANUSCRIPT BYZANTIN, LE GUIDE DE LA PEINTURE."

"GUIDE FOR PAINTING UPON WALLS.

"When you would paint upon walls, choose good lime; let it be as fat as lard, and it must not contain uncalcined stones. If it is poor and filled with this kind of stones, make a trough of wood, dig a hole of the necessary size, place the lime in the trough, and add water, which you will carefully stir with a stick until the lime appears well steeped. Pour this lime into a basket, placed over the hole, and which will arrest the stones. Then the milk of lime thus obtained must be left quiet, until it has coagulated and is capable of being taken up by the trowel."

"HOW THE LIME IS MIXED WITH STRAW.

"Take the purified lime and place it in a large trough, choose straw, fine and without dust; mix it with the lime, stirring it with a pick. If the lime is too thick, add water, to succeed in employing it easily for working. Allow these to ferment two or three days, and you can then lay the plaster ('arriciato.')"

"HOW THE LIME IS MIXED WITH TOW.

"Take the best lime you have prepared, place it in a small trough. Take tow, well cleaned from all bark and well crushed; twist it, as if to make a cord, and, by the aid of a hatchet, cut it into as small particles as you can; shake it well, to separate the dirt, and throw it into the trough, where you will mix it carefully by the aid of a trowel or pick. You will take care to try it, and recommence, (*working* it?) until the lime does not crack upon the wall. Allow it to ferment like the other, and you will thus have lime prepared with tow to form the superficial plaster, ('intonaco.')"

[1] Art of Fresco Painting. Mrs. Merrifield. 1846, Lond. pp. 12, et seq.

"HOW THE WALLS ARE PLASTERED.

"When you would paint a church, commence by the higher portions and finish by the lower. For this, you begin by placing a ladder. Then take water in a large vase, and throw some with a spoon against the wall so as to wet it. If the wall is built of earth, scratch the earth with a trowel as much as you can, because, above all at the vault, the lime will detach itself more tardily. Wet it again and polish the surface. If the wall is in brick, you will wet it five or six times, and you will make the plaster work of lime, of the thickness of two fingers and more, to retain humidity, and to allow you to take advantage of it. If the wall is in stone, wet it only once or twice, and put a much smaller quantity of plaster, for stone takes humidity easily and does not dry. During winter, lay one coat of plaster in the evening, and another, more superficial, the next morning. In the fine season, do what is the most convenient, and, after having laid on the last couch of plaster, equalize it well; allow it to take consistence, and work."

"HOW TO DRAW WHEN PAINTING UPON WALLS.

"When you would draw upon a wall, smooth its surface well. Then take a compass, and attach to both its branches pieces of wood, so as to lengthen it as much as you wish. Attach a small brush (pinceau) to the extremity of one of these sticks. You will draw out the nimbus of your personages, and you will indicate all the measures which are necessary. Then make a very slight sketch with ochre; finish your outlines. If you wish to correct (effacer) anything, employ oxy (red ochre or sinoper). Retouch the nimbus, repolish the surface well, and employ black; polish the drapery, and lay on the proplasm. Try to terminate very quickly that which you have polished; for, if you are too tardy, a crust will form upon the surface which would not absorb the colour. Work the face in the same manner; you will design the outline with a piece of bone cut to a point, and put on the flesh colour as promptly as possible, before the formation of a crust, as we have before said."

"HOW WHITE IS PREPARED FOR PAINTING ON WALLS.

"Take very old lime (chalk). Try it upon your tongue; if it is neither bitter nor astringent, but insipid like earth, it is good.

Take the precaution always to try if it is bitter or astringent; for that must be rejected, because the crust would form too quickly, which would much hinder the work."

"OF THE PREPARATION OF PROPLASM FOR PAINTING ON WALLS.

"Take green lake .... drachmas; deep ochre.... dr.; white.... dr.; black .... dr. Grind all these substances well and put a proplasm where you wish."

(Note.—The MS. does not give the quantities, which are at the option therefore of the artist.)

"OF THE DRAWING OF THE EYES AND EYEBROWS, AND OTHER PARTS, WHERE FLESH COLOUR IS EMPLOYED.

"Take umber or black, with an equal quantity of black wood, ("*bois noir*," is this charcoal?) Grind them well, and sketch the eyes, nose, hands, and feet. For the pupil of the eyes, very fine black must be employed, like that which is collected from the smoke of an oily wood, for if you employ the black which is in use for the grounds and draperies, it will soon be effaced."

"HOW TO MAKE FLESH COLOUR AND GLYCASM FOR PAINTING ON WALLS.

"Take white .... drs.; ochre of Thasos .... dras. (a yellow ochre); bole .... dras. (a bright red earth, the true Armenian earth.) Grind them with care upon a marble, and you will obtain a beautiful colour for flesh. By adding proplasm to this colour, you will obtain a glycasm, such as is used in choice pictures. If you wish to paint more quickly, you commence by making the flesh with this colour (flesh colour), and you will terminate the outlines by melting them with glycasm."

"HOW THE REDS ARE EMPLOYED.

"Make the mouths of young people with pure bole. You mix the red with the bole and the flesh colour for the margin of the lips, and you will use it for the shadows of hands or other members. In the shadows of aged persons, you can employ very fine bole; as for hair and beards, you act upon a wall as for pictures."

"HOW REFLECTIONS ARE GIVEN UPON A WALL WITH AZURE.

"Add indigo upon your pallet to the azure, to hinder it from spoiling upon the wall. Add white, in an equal quantity to the

indigo; grind them well together and gather them in a cup. You can then give the reflections with this preparation of azure. Dark umber can also serve for the same use."

"WHICH ARE THE COLOURS THAT CAN BE EMPLOYED UPON A WALL AND WHICH ARE THOSE THAT CANNOT.

"Picture white, (white lead,) tzinkiari, (light green,) lachouri, (purple,) lake, arsenic, cannot be employed in painting upon walls; all other colours can serve. Only you must observe that you cannot employ cinnabar upon any place outside the church and much exposed to the wind, because this colour would blacken. You must then mix it with much white. In the interior you can employ it, without seeing it turn black, by adding white or a small quantity of ochre of Constantinople."

"HOW TO MAKE NIMBUS IN RELIEF UPON WALLS.

"When you have drawn the saint, mark out the nimbus with a compass. Place then upon the nimbus a thick couch of lime, taking care to reserve for the hair. Then stick on the leaves of beaten gold and cover the lime entirely. Describe a fresh circle with the compass to form a clean outline."

"HOW TO EMPLOY AZURE UPON A WALL.

"Take bran, wash it and rinse it. Then allow the water which has served for this purpose to repose; then boil it, and when it is cooked you can mix it with azure and paint the grounds. Others insist that to make a water sufficiently glutinous the bran must be boiled for a very long time, then filtered. In any way, before employing azure, assure yourself that the wall is very dry."

"Note by Monsieur Didron."

"It would perhaps not be uninteresting to sum up a portion of these receipts and these processes, by relating the observations which I have made and the conversation which I held with Father Joasaph, one of the best painters of Mount Athos. The processes of this day are the same, nearly, as those of former times.

"Here, then, is the manner in which I saw a fresco painted in the Monastery of Esphigménou, by Father Joasaph, by his brother, by his first pupil, who was a 'diacre' and the future heir of the studio, and by two children of twelve or fifteen years of age.

"The porch of the church, or narthex, which they were painting

at the time of our passage, had just been built; it was scaffolded for receiving the fresco paintings at the upper part of the vault. Workmen, under the direction of the painters, prepared in the court the mixed lime which was to serve as the plaster. As two plasterings are made, there are two kinds of lime; the first, a kind of mortar rather fine, is mixed with straw cut small, which gives it a yellow colour; in the second, which is of a finer quality, they mix cotton or flax. It is with the lime of a yellow colour that they make the first plastering; it adheres to the wall better than the second. The second is white, fine, and makes a rather firm paste, by means of the cotton; it is this which receives the painting.

"The workmen then bring the yellow lime and apply upon the wall a layer of the thickness of about half a centimetre[1]. Upon this layer, some hours afterwards they spread a pellicle of the fine and white lime. This second operation demands more care than the first, and I have seen the brother of the painter Joasaph, a painter himself, apply this second couch of lime. THEY WAIT THREE DAYS FOR THE HUMIDITY TO EVAPORATE. If they painted before that time, the lime would soil the colours; afterwards, the painting would not be solid, and would not enter into the mortar, which would be too hard, too dry to absorb the colours. It need not be said that the thermometrical state of the atmosphere abridges or lengthens the interval which must be allowed to leave the plaster to dry suitably before painting.

"Before drawing, the master painter smooths the lime with a spatula; then, by means of a string, he determines the size which his picture should have. Within this picture, on the ground of his figures, he measures with a compass the dimensions which the different objects, which he wishes to represent, will have. The compass which Father Joasaph used was simply a cane bent double, divided in the middle, and adjusted by a piece of wood, which united the two branches and brought them together or parted them at pleasure. One of the branches was sharpened to a point, the other was furnished with a small brush, (pinceau.) A compass of a more simple, commodious, or economical fashion could not be made.

"The brush, which garnishes the extremity of one branch of the compass, is dipped into red; it is with this colour that the draw-

[1] A centrimetre is, in ancient measure, 4 lines and .4344, or about half an English inch.

ing is slightly traced and the picture sketched. The compass serves principally for the nimbus, the heads, and the circular parts; the rest is traced with the hand, which is only armed with a small brush (pinceau.) In less than an hour, Father Joasaph had traced before us an entire picture, in which figured Christ and his Apostles, of the natural size; he made this sketch entirely from idea, without any hesitation, carton or model, and without even looking at the figures already painted by him in other neighbouring pictures. I did not see him efface or rectify a single line, so sure was he of his hand. He commenced by sketching the principal personage, Christ, who was in the midst of his Apostles. He made first the head, then the remainder of the figure in descending. Then he drew the first Apostle on the right, then the first on the left, then the second on the right and left, and so the others, symmetrically. The painter traced his sketches, his hand raised and without using a rest; this instrument, used by our painters, would enter the still humid plaster. However, the hand is rested upon the wall itself when it trembles, or is fatigued.

"Inside this red line, which defines the outline of the figures, an inferior painter spreads a black ground[1], which he relieves with blue, but in a tint as flat as the black ground itself. It is upon this field that this painter, a kind of practitioner, designs the draperies and other ornaments. As to the nude, he does not touch it; that is reserved for the master. All the draperies are made, and the circular line of the nimbus is traced, before the head, the feet, and the hands.

"The master then takes this sketched figure, and forms the head. He spreads at two different times a couch of blackish colour, (noirâtre,) over all the face, and fixes the outline of the face with a colour still deeper. He paints two faces at once, going incessantly from one to the other, to exhaust all the colour contained in the pencil; the colour of one head must likewise have time to be imbibed into the wall while the second is preparing. Then with a yellow colour he makes the forehead, cheeks, neck, and the flesh parts. A first couch of yellow extinguishes the

[1] This "black ground" must be the proplasm, which, while wet, would appear quite black. The mixture of blue would prepare for the half tints, as in this process the lights are graduated into the shadows, passing over the prepared half tint. An improvement upon the practice of Theophilus, and of later date.

black colour; a second lightens the face[1]. Here the tint predominates, and the tone should be true. The painter tries the degree of colour upon the nimbus, which is traced, but not yet painted, and which serves him as a palette under these circumstances.

"After these two couches of yellow, one which kills the black, the other which lightens the flesh, you perceive the flesh appear. A third couch of this clear yellow, thicker than the two first, gives the general tone of the carnations. The painter has not made the face "bit by bit," but all at once; he spreads a couch over all the face before passing to another colour. The eyes alone are excepted; they are reserved for the end. Then, with a pale green, he softens the black, which he has left in the shaded parts, and which he had already enlivened with blue. Then, with yellow, he narrows the trespassing (empiétements) of the green.

"This green, which tempers the black, gives the shadows. The flesh thus apparent is made to live: he passes a rose colour over the cheeks, the lips, the eyelids, to lighten them and show the circulation of the blood there. Then the eyebrows appear under a deep brown, also the hair and beard, and then the outline of the face is determined.

"The eyes have remained black, under the two first and general layers. With a deeper black he forms the pupil, and the sclerotick with white; then a pale and fine rose colour gives the little luminous point of the eye; the eye is lit, and the figure sees.

"The lips were only indicated, the drawing of the mouth was too black; the painter lightens and terminates the mouth and the lips.

"He then surrounds with a very dark line the entire figure, to make it stand out. With us, also, at the Romane epoch, a deep line was hollowed out round a sculptured figure to give it relief.

"Then a few strokes of the pencil, of a rosy white, are given here and there, to subdue the vivacity of the red in certain parts of the flesh; then a few strokes of brown for the wrinkles of the aged; and at last a few strokes of different colours, to give the last touch to the heads and to finish them.

"Two heads are painted together, as I saw Father Joasaph practise; he was scarcely an hour in doing both. In five days Joasaph

[1] The glycasm, under the circumstances, would appear to M. Didron a "blackish" colour, and the flesh tints, different degrees of "yellow."

had painted a Conversion of St. Paul in fresco, a picture of three metres in breadth and four in height. Twelve personages and three large horses occupied this rather extensive field. This painting was certainly not a masterpiece, but it was better than that which would cost one of our painters, of the second order, from six to eight months. I even doubt that our great painters, charged with a religious composition, would execute it more uniformly well; there would be more excellencies, but more faults also in their work than in the fresco of Mount Athos.

"When the picture is finished, they wait until the lime has almost entirely dried; they then finish the figures. They attach gold and silver to the nimbus and to garments, they enrich the paintings with the finest colours, particularly Venetian azure, and they make the flowers and ornaments which decorate the interior of the nimbus, the stuffs of habits, the ground of the picture. For this, the grosser colours, which were used to paint the figures, must be very dry, so that they may neither spoil the precious colours, nor the silver or gold. The figure finished, it is named. A special artist, a writer, inserts the name of the personage in the field or nimbus, or about it: he traces upon the cartel which the figure holds, patriarch, prophet, judge, king, apostle, or saint, the consecrated legend, which the[1] 'guide of painting' commands. Afterwards it is not touched, all is finished.

"This is what I observed with the greatest care in the church of Esphigménou, of Mount Athos. While the painter was at work I interrogated him, and wrote upon the spot, and as under his dictation, what I saw and heard. They scarcely ever paint in oil, because, said Father Joasaph, to paint in oil we must wait until the plaster has become dry, and, as the colour would not penetrate into the lime, it would be less solid."

From these extracts it will be seen that sand or silica is dispensed with in the composition of the stucco, the peculiar action of which, by hastening the setting of the plaster, so much annoys the fresco painter. The binding of the lime is produced by mechanical means, instead of the chemical action which the process of Vitruvius and the later Italians undergoes; this would, by retarding the setting of the cement, obviate the necessity of piecemeal work, which is not spoken of in the Athos MS. The

[1] Ἑρμηνεία τῆς ζωγραφικῆς.

picture is all painted at once, an interval of three days being allowed before the painting is commenced. Care is taken that the first layer of paint is applied immediately after the polishing of the plaster, and that the lime or chalk used for painting is perfectly inert.

NIGRUM, c. 12. The black pigments used by the ancients were, according to the Greek and Roman writers, either black earths or carbonised vegetable substances, as in the present day[1].

In the "Tab. Voc. Syn." we find "Black is an earth which is called black stone, it is sufficiently soft for drawing. Black is likewise a colour from charcoal, ground, or it is made from the smoke of a lamp or candle. It is elsewhere called fuscus and elsewhere sanctonicus."

"Actramentum is also used in painting, when it is made from the smoke of a burning candle or lamp, or from the charcoal of a soft wood, or of the vine." Idem.

Eraclius[2] speaks of the black from resin burnt, also of "the charcoal of soft wood and of the stones of peaches, which are profitable ground up with gluten; nor less so are the twigs of the vine burnt." He adds, "but vine twigs become of a blacker colour if steeped in the best wine and afterwards burnt, gluten being added."

In the Sloane MS. 1754, of the fourteenth century, the black directed to be used is vine black, "nigrum optimum ex carbonibus vitis."

Cennino Cennini speaks of blacks of many kinds. "Negro, egli è una pietra negra, tenera, e'l colore è grasso." He also speaks of vine black as well as the black chalk, and of peach-stone black and of black made by burning linseed oil in a recipient.

Sir H. Davy found that the blacks in the Baths of Titus, the Baths of Livia and the Aldobrandine Marriage all deflagrated with nitre, having all the properties of carbonaceous blacks.

OLEUM LINI, c. 20. Linseed, walnut and poppy oils were known to Theophilus, and probably all of them to the Greek painters, as drying oils fit to be used in painting. Linseed oil could not have remained long unknown to the Egyptians; great cultivators

[1] Pliny. L. 35, C. 25. Dioscor. L. 5, cc. 139 and 140.

[2] MS. Le Begue. Paris, Bib. du Roi, No. 6741, Art. 243.

of flax, skilful in the arts and in medicine, they could not have overlooked the production of an oil from the linseed nor have been ignorant of its peculiar properties.

In the British Museum are stone sculptured figures which are Egyptian, and have been painted with an unctuous vehicle which appears to have been oil. Two seated figures painted in different colours, one of them red, particularly show this. Compared with the paintings on a fragment of wall opposite to these figures, and which are also Egyptian, the difference of the vehicle can, even at this lapse of time, be plainly observed.

Dioscorides, and the Arab writers on medicine who follow him, speak of linseed oil.

The corruption of the word "encaustic" has already been remarked, "see Incaustum;" and the signature "ἐνέκαεν,"[1] or "enecausen," of the Greek artists, might well lose its orignal signification in painting also; the term remaining while the process changed. Pamphilus, the master of Apelles, is stated to have introduced many novelties into the art; he is asserted by Pliny to have painted in a different style from former painters and to have been in the habit of painting small tablet pictures[2]. These remarks, however vague, coupled with the invention of the "atramentum" of his pupil, Apelles, may cause us to enquire whether "oil" was unknown to Pamphilus?

The first mention I can find of the use of oil in painting is by Vitruvius[3], who directs that Punic wax be mixed with oil in the preparation of walls for receiving colours, and for the application of colours, which will not bear lime, in coating walls. This is an encaustic process, however.

Pliny gives the same directions as Vitruvius[4]. This author likewise mentions walnut oil by the Greek term "Caryinum."[5]

The Roman writers drew their knowledge upon these subjects from the Greeks, who were their masters in all the arts of luxury and elegance; more inventive and theoretical than the Romans, these propagated the literature, sciences and arts, which the latter did but practically adopt. It is in a Greek (Byzantine) MS. that

[1] Pliny. N. Hist. L. 35, c. 11.
[2] Id.
[3] Vitruv. de Archit. L. 7, c. 9.
[4] Pliny. Nat. Hist. L. 33, c. 7
[5] Id. L. 24, c. 14.

the first positive direction for the use of linseed oil, as a vehicle for paint and a varnish, is found.

This MS. is stated by Muratori[1] to be of the eighth century; it is rather carelessly given by him, contains, directions for dyeing skins, making coloured glass, the composition of colours, varnishes, &c., and a description of various substances used in the arts. Linseed oil is thus noticed in it. "Lineleon, ex semine lini fit," p. 372, is the λινηλεον of Dioscorides and the λινόλαδον of the modern Greeks; linseed oil.

The recipe for a composition for pigments or varnish is given. "De compositio Linei," p. 380. "Compositio; Lineileum ℔. II. gumma ÷ (sescuncia) resina suppini ÷ I. Omnia trita, decoquantur in vaso terræ."

"The composition of Lineum." Linseed oil, 2℔.; gum sandarach, 1½℥.; Larch (or Venice) turpentine resin, 1½℥. All ground, they are cooked in an earthen vessel."

There is no doubt here of an oil varnish, or vehicle which was used by the Greek painters. Again, "De Lineleo." "Lineleon *exauratione,* Lineleon liber II. gumma ÷, resina ÷ crocus solidus II.℔. Ista trita et commisce, quemadmodum superius."

"Of Lineleon." "Linseed oil *inspissated,* (quasi ab exareo, to wax dry,) or boiled linseed oil, 2℔.; gum sandarach, 1½℥; pine resin, 1½℥; solid yellow, 2℔. These, ground and mixed together as above." If this crocus solidus is the yellow aloes, it is a varnish which has been much in use at a later period in Italy. It may, however, be an ochre, and the composition one for laying on gold; it proves, however, the mixture of varnish with colours, and it is a very curious circumstance, that at a very early period in England painters were called "gilders."

The composition of a varnish which is called "lucidis" is a singular mixture, some of the ingredients given not being, under any circumstances, soluble in oil. I give the whole chapter for the curious.

"De lucide ad lucidare. Super colores quale fieri debet." The weights are in sescunciæ, ÷, or 1½ ounce. "Lineleon ÷ IV. terebentina ÷ II. galbanum ÷ II. larice ÷ III. libanum ÷ III. murra ÷ III. mastice ÷ III. veronice ÷ I. gumma cerasi ÷ II. flore puppli ÷ II. gumma amygdalina ÷ II. resina sappini ÷ II. Quæ pisandæ sunt. Pisa et grilela, et cum superius mitte in

[1] Muratori, Antiq. Ital. Medii Ævi. V. 2, p. 269.

gabata auricalcha. Et mitte in fornaculiclo, et sine flamma coce, ut non exeat foras, et post cola cum linteo mundum. Et si radaverint, decoque, ut usque dum spissa fiant, et qualibet opera picta aut scarpilata, inlucidare super debeas. Et pone ad solem. Desicca illam."

Eraclius, the next author upon this theme, probably of the ninth or early in the tenth century, speaks of linseed oil, and of its use with colours, in a more decided manner, in the MS. of John Le Begue, in the treatise entitled "Liber tertius et prosaicus Eraclii antedicti, de coloribus et artibus prædictis."

The Le Begue collection from Eraclius, however, contains many chapters which are wanting in the Cambridge MS., which only gives one chapter not to be found in the Paris MS., "De plumbacione auri vel Argenti." p 24. These chapters have all the proofs of authenticity, and are the source from which many of the early MS. writers have drawn.

"De oleo, quomodo aptatur ad distemperandum colores." "Calcem in oleo mensurate pone, et illud despumando, coque; cerosium in eo secundum quod de oleo fuerit pone, et ad solem per mensem vel amplius frequenter removendo pone; scito quod quanto diutius ad solem fuerit tanto melius erit. Postea cola et serva, et colores inde distempera."

"Put lime into oil by degrees and boil it, skimming it; put ceruse into it according to the quantity of oil, and place it in the sun for a month or more, frequently stirring it; know that the longer it has been in the sun, so much better it will be. Afterwards strain it and keep it, and distemper colours with it."

This is a very curious as well as valuable passage. It is not only a proof of the attainment of a great perfection in the art of painting "oil" as a material for tempering colours in painting, but it is almost as good a formula for the preparation of a drying oil as could at this day be given. A patent has lately been taken out for treating oil with fresh slacked lime during the process of preparing a drying oil with the per-oxide of lead; we here find the same means employed during the ninth or tenth century, probably long before that time, for it was impossible that the Greeks could have overlooked the action of the metallic oxides of lead or zinc upon oil of linseed: the "plumbum combustum et oleum," "massicot, or minium and oil," of Cornelius Celsus and the other Roman writers on medicine, produced effects which could not have been overlooked. Marcellus, who wrote under the empire of Marcus

Aurelius, has given a singular recipe for a "drying oil" for the time in which he wrote; although not intended as such:[1]

"Oleum vetus, quantum mittendum fuerit pro modo specierum supra scriptarum, mittes in ollam novam, et calefacies leni flamma vel potius igne, tunc mittes, sed paulatim et manu inspergens, lythargyrum bene tritum, et assidue spathomela agitabis, postea aut picem brutiam tritam mittes,"[2] &c.

In describing the method of painting on wood or stone, Eraclius directs that the wood or stone be well dried in the sun or at the fire; after this, white oil colour is to be painted over it two or three times with a flat brush; afterwards it is to be primed with the hand or brush with a thick white oil paint; this, when half dry, is to be smoothed with the hand, until all is as smooth as glass: he adds, "you can then paint upon it with all colours distempered with oil," "tunc vero desuper poteris de omnibus coloribus et cum oleo distemperatis pingere." Nothing can be clearer than this; and that pictorial or other ornamental work is intended, is evident, for he follows with a direction for "marbling," "if you prefer it;" the whole afterwards to be varnished in the sun.

Theophilus, however, who professes to teach "all that Greece knew in the art of painting," ends all doubt upon the subject of the employment of "oil colours" for pictures in his twenty-sixth chapter. Upon a varnished ground of tin leaf fixed upon wood he directs—"Take the colours which you wish to lay on, grinding them carefully in linseed oil, without water, and make the tints of countenances and draperies, as you have done above, with water; and you will vary with their colours beasts, birds, or leaves, as it may please you." The reluctance to part with a long received impression must therefore be set aside: and it must be allowed that the Greeks certainly, most probably the Egyptians, knew the advantage of oil as a vehicle for pigments.

In the MS. from Mount Athos a recipe for preparing a drying oil is given. The oil intended is most likely linseed, but I have not been able to trace the origin of the word Πιζῆρι, Peséri[3]. "How to prepare peséri:"

"Take peséri and put it into a large metal basin; expose it to an ardent sun forty days. Take care, however, not to allow it to

[1] Medici Antiqui. fol. See Marcellus.
[2] Raspe.
[3] Manual d'Iconogr. Chrét. Didron, p. 39.

become too solid, for there is peséri which is very quickly prepared, and other more slowly. When it has the consistence of honey it will be good; if you allow it to thicken more, you can neither mix it with other substances, nor spread it over pictures smoothly. You will therefore be careful to cover it every evening, or to take it into the house, for the dew of the night injures it. When it has arrived at a suitable state, you will pass it through a cloth to free it from hairs or insects which may have soiled it, and you will then have peséri baked in the sun."

Peséri is likewise, in the same MS., directed in the preparation of a ground for paintings.

I have here only quoted from the old part of the manuscript, the different recipes at the conclusion of the first book having been added from time to time, some of them being as late as the sixteenth century.

The Sloane MS. 1754, " De coloribus illuminatorum sive pictorum," and which is of the fourteenth century, speaks of oil as a vehicle for colours upon wood or plaster.

In the Le Begue MS., also, " Frater Dionysius," " Johannes de Modena," " Petrus de Sancto Audemaro," also speak of oil to be used with certain colours, as white, greens, blues, blacks, reds, and yellow, upon wood or plaster.

John Le Begue himself, who was born in 1368, who finished his collection relating to the arts in 1431, and who must have been forty-two years of age at the time when, according to Vasari, the first picture in oil was painted by the inventor, Van Eyck, gives directions for preparing oil for painting. I give the old French receipt: " Si vous voulez appareiller oile pour detremper toutes manieres de couleurs, prenez chaux vive, avec autant de ceruse comme est l'oile. Puis mettez au soleil et ne le mouvez jusques à un mois ou plus, car quand plus y sera et mieulx vandra. Puis le coulez et gardez très bien l'oile, et de cette oile gardée et ainsi préparée pouvez detremper toutes couleurs ensemble et chacun par soy."

Also Le Begue speaks of the oils of linseed, hempseed and walnuts as fit for painting:

" Si vous voulez rougir tables au aultres choses, prennez oile de lin, de chauvre, ou de noix, et melez avec mine ou sinope sur une pierre et sans eau. Puis enluminez a un pincel ceque vous voulez rougir." Art. 335.

Le Begue gives a curious recipe for a glutinous preparation

which would partake of the quality of an oily vehicle, and which, or something very like it, appears to have been used by some of the Venetian artists in laying in their pictures at a later period:

"Aqua in qua semen lini diu, per diem et noctem saltim, steterit, recipit ab ipso semine glutinositatem quæ ipsam facit aptam ad distemperandum colores." Art. 347.

"Water, in which linseed has remained for some time, for a day and a night at the least, receives from the seed a glutinous property which makes it fit for tempering colours."

Cennini, who mentions oil colours for painting upon walls, and the use of which in his day was very extended, as he tells us that the Germans used it much, "che l'usano molto i tedeschi,"[1] gives directions for the preparation of oils for painting both by the sun and by boiling over the fire until the reduction of one half of the bulk[2].

The Rev. Mr. Bentham has noticed, under the title of "Nova Pictura," in the Sacrist's Roll of annual expenses for the cathedral church of Ely for the year 1335, that items for the purchase of oil for the painters are found. The instances produced by Walpole, Pownall, and others, likewise place beyond a doubt the fact that painting in oil was practised in pictorial decoration in our own country before the thirteenth century; and Muratori[3] concludes that "the art of painting was never wholly lost in any of those countries which had once been provinces of the Roman empire."

Pallidus, c. 1. Pallidus is a colour not strictly white, but somewhat inclining to shadow. Tab. Voc. Synon.

Theophilus uses this term in a sense approaching to that of Catullus, who writes, "Statuâ inauratâ pallidior," more pallid than a gilt statue.

Posc, c. 3. Posc, à fuscus, or φαῖος, dark or dusky. Scaliger dict. quasi φωτοσκία, i. e. lucis umbra, à φώσκω, luceo. The mixture of deep green and red, in order to form this shade tint, would, united with the membrina, form a graduated warm grey tint, calculated for a shadow or half tint, "lucis umbra."

In the Romaic, "Πύξος" signifies "morella," a species of solanum yielding a black berry, from which a dark colour was procured for painting and dyeing. This was the "morello" of the

[1] Cennino Cennini, Trat. della Pittura. Roma. C. 89.
[2] Idem. C. 91 and 92.
[3] Muratori, Antiq. Medii Ævi. T. ii. p. 354.

Italians, the "moreau" of the French, and our "murrey." Posc and Πύξος are therefore derived from the same source.

In the Tab. Voc. Syn. we have "Morellus, est color ex rubeo et nigro factus;" this is our murrey. The puzos or morelle appears to have disappeared upon the introduction of indigo.

The γλύκασμα or "softening" of Pauselinos[1] is thus composed: "Glycasm." "Take two parts of flesh colour, and one part, or a little less, of proplasm, (a dark shade colour,) unite them in a shell, and you will have a glycasm which will serve you for making the flesh you wish."

In the same MS. the "proplasm" πρό πλάσμα of Pauselinos[2], which is correlative with the second "posc" of Theophilus, is thus composed: "Take white, ochre, green, black (the proportions are left to the judgment of the artist). Grind all this together upon a marble, and gather the mixture into a small bottle, to imbue the places where you wish to paint flesh."

This proplasm of Pauselinos shows that he painted differently from the method given by Theophilus, who superposes the shadow colours, while Pauselinos painted into, or upon, his shadows.

Pauselinos of Thessalonica, a painter of the twelfth century, was the Raphael or Giotto of the Byzantine school[3].

Prasinus, c. 1. The "prasious" of the Greeks was a green earth, or jasper à πράσον, porrum; the Catholicon calls "prasis" or "prasim" "creta viridis," a green chalk or clay, and prasius, "lapis viridis," a green stone. St. Isidore writes "prasina," that is, green clay, which is produced in different places, the best, however, in Lybia Cyrenesi. (Lybia Cyrenea, called by Ptolom. Pentapolis, from the five cities it contained. Africa.)

The prasinus of Theophilus appears to be an acetate of copper, of which "confection" he gives the recipes at the end of this first book. Theophilus afterwards mentions "succus," and "viridis," which appears to be "terra verte."

In the Sloane MS. 1754, there is the following passage: "Viride bonum est quod de Grecia venit. Item aliud viride est quod ter-

[1] Manuel d'Iconographie Chrétienne Grecque et Latine, par Didron et Durand. Paris, 1845, p. 35. Athos MS.

[2] Idem, p. 33.

[3] Idem, p. 8.

restrè dicitur, et quod terra sit et de monte Galboe affertur." (A hill in Syria, six miles from Scythopolis, or Bethsan.)

Probably this last kind is our "mountain green."

"The "viride Grecum" is an acetate of copper which Theophilus calls "viride Hispanicum."

The green earth was likewise called "theodote." "Theodote, Græce-Latine, est creta viridis, cujus melior nascitur in creta Cirina, (Cyrene,) et aliter, videlicet in Græco 'theodoce' dicitur." Tab. Voc. Syn.

Another acetate of copper green called "viride rothomagense" was made in the same manner as the "viride salsum" of our author, soap being used to anoint the copper instead of salt and honey[1].

Davy states that "the greens in the Baths of Livia and of Titus are oxides of copper," (probably laid on in the state of acetate,) and that "on the fragments found near the tomb of Caius Cestius he found three varieties of green: one approaching olive was Verona green earth; a pale grass green was carbonate of copper and chalk; a sea green was copper mixed with blue frit;" (the Pozzuoli cæruleum of Vitruvius, doubtless.) The greens in the Aldrovandini are all of copper. Probably native earths[2].

Cennino Cennini, from observation, does not recommend the "verde rame," but "terra verde;" "verde azzurro;" "verde d'orpimento e d'indaco;" in secco, "di azzurro e giallorino." These composed greens have proved more permanent than the factitious acetates of copper.

Rubeum. Theophilus mentions the *Rubeum* several times in this book; he here explains the kind "comburitur ex ochra," a factitious bright sinoper.

Sellæ equestres et octoforos, c. 22, ὀκτωφόροι. Lectica, quæ ab octo servis gestatur, a litter borne by eight men. *Sueton.* This luxury, it is seen, emanated from the Romans, or more likely from the Greeks of the Lower Empire. Walpole[3] tells us that, at the time of the Conquest, painting was not confined to the church, or to the

[1] Liber Petr. de Sancto Audemaro, de coloribus faciendis. MS. Le Begue. Art. 156.

[2] Davy's Works, Inquiry into the Colours of the Ancients. V. vi. p. 131.

[3] Walpole's Anec. V. i. p. 3.

portraits of great men, but was employed for various other purposes, particularly for ornamenting apartments, furniture, and shields, &c., of persons of rank and fortune.

As this chapter immediately follows the mention of colours ground in oil, and the composition of an oil varnish, it is more than probable that, considering also the nature of the work, these saddles, &c., were painted in oil colours, and, as directed, afterwards varnished.

In the reign of Henry II., (1154—1189,) Henry de Blois, archdeacon of Bath, and chaplain to the king, exclaims against the luxury indulged in by the military men of his time, and censures the ostentation of some of these barons: "They carry shields into the field so richly gilded, that they present the prospect of booty rather than of danger to the enemy, and they bring them back untouched, and, as I may say, in a virgin state. They also cause both their shields and saddles to be painted with the representations of battles and equestrian combats, that they may please their imaginations with the contemplation of scenes in which they do not choose to engage." [1]

Sinopis, c. 1. Theophrastus tells us that Σινωπικὴν or Sinopic earth was dug in Cappadocia, but carried to Sinope for sale; also, "that there were three kinds of the Sinopic: one of a deep red colour; another pale; the third of a middle colour between the two, which was called the pure and simple kind, because it was used without mixing, whereas they mix the others." [2] He adds, "there is also a kind of sinoper made from ochre, by burning, the invention of Cidias, who observed that some ochre, in a house on fire, when half burnt assumed a red colour." [3] Sinopis thus became a general name for all the red ochreous earths or reddles, the "miltos" of the Greeks, and "rubrica" of the Romans.

The Μίλτος of Theophrastus is certainly no other than the red ochreous earth or ore which owes its colour to iron. He gives the different varieties of miltos, and tells us that "the best came from Cea [4], particularly that which was taken from the reddle pits;

[1] Op. Petri de Blisensis, Ep. 94, pp. 146, 147.

[2] Theophr. Hist. of Stones. C. 94.

[3] Id. C. 95.

[4] Id. C. 92. The Τζία of the modern Greeks, or Lango, an island in the Archipelago; the country of Hippocrates, Keia, or Koos.

for it is also sometimes found in the iron mines. There are also, besides these, the Lemnian and Sinopic miltos; there are particular pits in Lemnos, in which nothing but the earth is dug."[1]

The Lemnian miltos must not, however, be confounded with the "σφραγίς," or "terra sigillata." The sealed earth, used in medicine, was an unctuous clay, of a pale red colour, which was mixed by the priests alone, with the blood of goats sacrificed, and then sealed by them. It was the "Lemnian reddle," not the "Lemnian earth," which was used by painters[2]. Pliny confounds the two substances[3].

Salmasius was the first to detect an important error in the different editions of Pliny, and to restore a passage, according to his judgment, to the original intention of the author[4].

The passage[5], "Milton vocant Græci minium, quidam cinnabari," "the Greeks call minium miltos, some cinnabar," has been restored by him to "(Rubicam) milton vocant Græci, minium que cinnabari;" a statement which would be certainly correct, and therefore fairly attributable to Pliny, many of whose "*errors*" have been more the mistakes of his commentators than his own.

Salmasius thus restores the whole passage: "Jam enim Trojanis temporibus rubrica in honore erat, qui naves ea commendat, alias circa picturas, pigmentaque rarus, milton vocant Græci, miniumque cinnabari." The milton certainly relates to the rubrica. Hill remarks[6], that "Homer, speaking of the Grecian ships, writes 'Νῆας μιλτοπαρῄους,' and that it is impossible he should mean by it that they were stained with minium or cinnabar, which was not known till after his time."

This correction of an error which has so long existed, and been variously propagated, is certainly important. Sinoper or miltos has been used as a colour from time immemorial, and we have proof that the Egyptians used it: the Assyrians likewise. Ezekiel, c. xxiii., v. 14, speaks of "men portrayed upon the wall, the likeness of the Chaldeans portrayed with sinoper." The Hebrew שָׁשַׁר, "μίλτο γραφίδι," coinciding with the Greek "miltos,"

[1] Theophr. Hist. of Stones. C. 93.
[2] Galen. L. I. de Antidotis. Dioscorides.
[3] Pliny, Nat. Hist. L. 35. C. 6. Hill on Theophrast.
[4] Salmasius, Plinianæ Exercitationes, fol. Traj. ad Rhen. 1689.
[5] Pliny, Nat. Hist. L. 33. C. 7.
[6] Theophrast. by Hill, p. 96.

it is therefore "sinoper," not "vermilion," which is intended, and which latter is given in our translation. Jeremiah, c. xxii., v. 14, "It is ceiled with cedar, and painted with "vermilion;" it should be rendered "sinoper."

Some of the varieties of hæmatite outwardly resemble mineral cinnabar: hence another source of error, which the observant have been careful to point out.

Our own country produces as fine varieties of sinoper as any. Hill states[1], that the reddle sometimes sold in London, under the name of Indian red, was much the finest he had ever seen, and was from among the iron ore in the forest of Dean, and not from a reddle pit: it was not inferior to that of Ormuz in the Persian Gulf, so much valued as Indian red.

I hope to have an opportunity of showing, in a work now in progress, that this *English colour* has been much appreciated, and was famous during the best periods of the art in the fifteenth and sixteenth centuries.

De Boot thus notices this variety[2]: "Hæmatitis a sanguine nomen habet, Germanice 'Bluet-stein' vocatur. Quanquam interdum niger, interdum flavus, interdum ferri colorem habeat. Strias antimonii instar habet. Dum uritur, minii colorem imitatur. Habet cinnabari similem colorem."

Theophrastus describes the Hæmatite[3], as "dense, solid, dry, or, according to its name, seeming as if formed of concreted blood;" he adds, "there is also another kind of it called xanthus, which is not of the colour of the former, but of a yellowish white, which colour the Dorians call xanthus."

As the yellow ochres are "hydrates of iron," so are the red ochres "oxides of iron," and in proportion to the quantity of oxygen contained in the substance the deeper does the colour become. The trit-oxide, or purple oxide, is the highest point of oxidation. The greater proportion of clay which the yellow or red ochres possess, the brighter will be the colour. Our sinoper is a compact heavy substance of a deep red colour, soiling the fingers when handled, and answering to our Indian red.

[1] Theophrast. by Hill. Pp. 124, 125.
[2] Boethius de Boot. Gemmarum et Lapidum Hist. Leyd. 1647. C. 205.
[3] Theoph. Hist. of Stones. C. 66.

SUCCUS, c. 14. Succus, generally, is the green colour or "sap" of plants, to which other colours were often added for a variety of greens. Tab. Voc. Syn. "Succus" is ordered to be mixed with greens and black for shadow, and to be lightened with white. "Succus" is also, in the same table, described as "a colour resembling indigo;" and "others say that it is red, darker than minium and lighter than sinoper, and it is also called menesch." Where, however, these colours are intended, the base of the colour is named as "succus folium," a purple or violet; for the drapery for which it is directed is called "violaticum." "Succus Sambuci," a purple colour made from the berries of the elder tree; Theophilus directs this to be used as indicum, or menesch, with orpiment.

The following from Eraclius will give the usual process pursued for the manufacture and use of succus [1].

"DE VIRIDI COLORE, QUOMODO FIERI POSSIT AD QUOD VOLUERIS DEPINGERE.

"Sic poteris viride tibi, pictor, habere colorem,
Cum foliis albam morellæ contere cretam,
Hoc in marmorea pariter quoque contere petra,
Usus ad pene liquidum dum fiat utrumque
Et post hunc succum pincello sume probandum.
Hinc quascumque cupis scripturas conde colores
Ne cretæ nimium ponas tamen ante cavendo."

THRONI ROTUNDI, c. 16. Thrones were represented by the Byzantine Greeks as wheels of fire surrounded by wings. The centre of these wings is sprinkled with eyes, and the appearance of the figure represents a royal throne. MS. de Mont Athos. Didron. Man. d'Iconographie Chrétienne, Paris, 1845.

In the church of the convent of Césariani, upon Mount Hymettus, the Trinity is represented in fresco. The Father, as an old man, the Son, as a man of thirty-five years, the Holy Ghost, as a dove, are all figured as we are accustomed to see them. The nude feet of the Father and Son are placed upon a circle of fire, winged with two wings of flame; it is thus that the Greeks figured the chorus of angels, to which they gave the name of Thrones. This winged and flaming circle is as the throne of the Divine feet. Manuel d'Iconographie Chrétienne, 2me Partie.

The classification of angels by St. Denys l'Aréopagite, is as follows:—

[1] Eraclius de Artibus Romanorum. L. 2. MS. Le Begue. Bib. Royale, Paris.

First Order.	*Second Order.*	*Third Order.*
Séraphins.	Dominations.	Principalities.
Chérubins.	Virtues.	Archangels.
Thrones.	Powers.	Angels.

This division into three great classes, again subdivided into three sections, has been adopted by the two churches, Greek and Latin. St. Gregorius of Niscia, St. Chrysostome, St. Ignatius, St. Jerome, Origenes, Pope St. Gregory (L. 2 Moral.), St. Bernard, Denys le Petit, Jaques de Vorage, Dante, and others, have employed themselves upon this hierarchy of celestial spirits. *Idem, p. 75.*

Veneda. Veneda, a grey colour, is stated to be "a colour made from the mixture of black with a little white lead; if required for a wall, lime is put in the place of white lead." Tab. Voc. Syn.

This is the berectinus of the Lombards, and the "berettina" of Cennini, "cioè colore bigio," o ver bigia. C. 22.

A light blue colour was one of the colours of the factions in the circle. White, light blue or *watchet*, green, and red: to which were added by Domitian, yellow, or cloth of gold and purple. Sidonius Apollinaris upon this subject has "micant coloribus, albus cum *Venĕto,* virens, rubeusque," Holyoke; but, "Venetuos occulos, appel. eos qui suffusione affecti sunt," grey. Berectinus color, so called in Lombard dialect, is a colour between white and black, which, in the Latin, is called "elbus" or "elbidus," as in the Catholicon; and by the Gauls it is called "grisus." St. Isidore writes it, "elbum." Tab. Voc. Syn.

INCIPIT LIBER SECUNDUS.

THE BEGINNING OF THE SECOND BOOK.

INCIPIUNT CAPITULA.

CHAPTERS.

PROLOGUS LIBRI SECUNDI.

INCIPIT PROLOGUS

IN

LIBRUM SECUNDUM.

IN præcedenti libello, frater karissime, sinceræ dilectionis affectu non me piguit tuæ indoli insinuare, quanti honoris quantuique perfectionis sit, otium declinare, et inertiam desidiamque calcare; quamque dulce ac delectabile, diversarum utilitatum exercitiis operam dare, juxta vocem oratoris cujusdam dicentis:

"Scire aliquid laus est; culpa est, nil discere velle."

Nec pigritetur quispiam, eum, de quo Salomon ait, *qui addit scientiam, addit et laborem*, apprehendere; quia, quantus ex eo procedat animæ corporisque profectus, diligens meditator poterit advertere. Nam luce clarius constat; quia, quisquis otio studet ac levitati, fabulis quoque supervacuis operam dat, ex scurrilitati, curiositati, potationi, ebrietati, rixæ, pugnæ, homicidio, luxuriæ, furtis, sacrilegiis, perjuriis et cæteris hujusmodi, quæ contraria sunt oculis Dei respicientis super humilem et quietum et operantem in silentio in nomine Domini, et obedientem præcepto B. Pauli apostoli: *Magis autem laboret operando manibus suis, quod bonum est, ut habeat unde tribuat necessitatem patienti.* Hujus

PREFACE

TO

THE SECOND BOOK.

IN the preceding book, dearest brother, through a disposition of sincere affection, I have not hesitated to convey to your virtuous disposition how much honour and perfection there is in avoiding indolence, and in contemning ignorance and sloth; and how sweet and agreeable it is to indulge in the exercise of divers usefulness after the word of a certain author, who says:—

"To know anything is praiseworthy; it is a fault to be unwilling to learn."

Nor let any one be slow to understand him, concerning whom Solomon has said, "He that increaseth knowledge increaseth labour," because whoever carefully meditates may mark what perfection of mind and body may result from it.

For it is evident; clearer than the light; because whoever gives his mind to sloth and levity, also indulges in vain trifles, and slander, curiosity, drinking, orgies, quarrel, fight, homicide, excess, thefts, sacrileges, perjury, and other things of this kind, which are repugnant in the eyes of God, overlooking the humble and quiet man, working in silence in the name of the Lord, and obedient to the precept of the holy Apostle Paul: "*But rather let him labour, working with his hands the thing which is good, that he may have to give to him that needeth.*"

I 2

imitator ego desiderans fore, apprehendi atrium regiæ[1] Sophiæ conspicorque cellulam diversorum colorum omnimoda varietate refertam et monstrantem singulorum utilitatem ac naturam. Quo mox inobservato pede ingressus, replevi armariolum cordis mei sufficienter ex omnibus, quæ diligenti experientia sigillatim perscrutatus, cuncta visu manibusque probata satis lucide tuo studio commendavi absque invidia. Verum quoniam hujusmodi picturæ usus perspicax non valet esse, quasi curiosus explorator omnibus modis elaboravi cognoscere, quo artis ingenio et colorum varietas opus decoraret, et lucem diei solisque radios non repelleret. Huic exercitio operam dans vitri naturam comprehendo, ejusque solius usu et varietate id effici posse considero, quod artificium, sicut visum et auditum didici, studio tuo indagare curavi.

[1] "agiæ," *Cod. Lipsiensis.*

EXPLICIT PRÆFATIO.

I, desiring to be the imitator of this man, have approached the porch of holy Sophia, and beheld the chancel filled with every variety of divers colours, and showing forth the nature and utility of each. From which, having forthwith entered with unwatched footstep, I filled up the storehouse of my heart fully, out of all; which I have set forth with clearness, having, by careful experiment, thoroughly examined one by one for your study, all these things sufficiently approved by the eye and hands, without jealousy. But since the practice of this kind of embellishment cannot be of quick apprehension, like a diligent inquirer I have greatly laboured to inform myself, by all methods, what invention of art and variety of colour may beautify a structure and not repel the light of day and the rays of the sun. Applying myself to this exercise, I comprise the nature of glass, and I consider that this can be effected by the use and variety of it alone. This art, as seen and reported I have learned, I have laboured, for your observance, to fathom.

END OF THE PREFACE.

INCIPIT LIBER SECUNDUS.

CAPUT I.

DE CONSTRUCTIONE FURNI AD OPERANDUM VITRUM.

SI sederit in animo ut vitrum componas, primum incide ligna faginea multa et exsicca ea. Deinde combure ea pariter in loco mundo, et cineres diligenter colligens, cave ne quicquam terræ commisceas. Postmodum compone furnum ex lapidibus et argilla, longitudine pedum xv et latitudine x, in hunc modum.

Primum pone fundamentum in utroque longitudinis latere spissitudine unius pedis, faciens larem in medio firmam et æqualem, lapidibus et argilla, dividens eum inter tres partes æquales, ut duæ per se sint, et tertia per se divisa, muro in latitudine posito. Deinde fac foramen in utraque fronte latitudinis, per quod possint ligna et ignis imponi, et ædificans murum in circuitu usque ad latitudinem quatuor pedum, fac iterum larem firmam et æqualem per omnia, et sine murum divisionis aliquantulum ascendere. Post quæ fac in majori spatio quatuor foramina in uno latere longitudinis, et quatuor in altero per medium laris, in quibus ponantur vasa operis, duoque foramina in medio per quæ flamma possit ascendere, et ædificans murum in circuitu, fac duas fenestras quadras in longitudine et latitudine unius palmæ, in utroque latere contra foramina unam, per quas vasa imponantur et ejiciantur cum his, quæ in illis mittuntur. Fac etiam in minori spatio foramen per medium laris juxta parietem medium, et fenestram ad mensuram palmi juxta parietem frontis exteriorem, per quam possit imponi et assumi quod necessarium est operi.

THE BEGINNING

OF

THE SECOND BOOK.

CHAPTER I.

OF THE CONSTRUCTION OF THE FURNACE FOR MAKING GLASS.

SHOULD you intend to make glass, first cut a quantity of beech-wood logs and dry them. Then burn them together in a clean spot, and, carefully collecting the ashes, take care that you mix no earth with them. Afterwards build a furnace of stones and clay, in length fifteen feet and breadth ten, in this manner.

First lay the foundation on both sides, a foot in thickness, making a hearth in the midst, firm and even, of stone and clay, dividing it into three equal parts, so that two parts may be together, and the third divided by itself, by a wall placed across. Then make an opening in each end of the breadth, through which wood and fire may be introduced, and building up a wall around at the distance of four feet, make again a firm and smooth hearth throughout, and allow the wall of separation to surmount a little. After which make, in the larger space, four openings on one side, lengthwise, and four on the other, through the midst of the hearth, in which the work vessels are placed; also two openings in the middle, through which the flames may rise; and building a wall round about, make two windows, four palms in length and one in breadth, one on each side, opposite the openings, through which the vases, with those things put into them, are introduced and taken out. Make also an opening in the smaller space through the middle of the hearth near the centre wall of separation, and a window of the measure of a palm near the exterior wall of the front, through which whatever is necessary for the work can be placed and withdrawn. After

Postquam hæc ita ordinaveris, fac partem interiorem cum muro exteriori in similitudinem fornicis arcuari, interius altitudine modice amplius dimidii pedis, ita ut superius larem facias æqualem per omnia, cum labro altitudine trium digitorum in circuitu posito, ut quicquid operis vel utensiliorem superponitur non possit cadere. Iste furnus dicitur clibanus operis.

CAPUT II.

DE FURNO REFRIGERII.

FAC et alium furnum, longitudine x pedum et latitudine VIII, altitudine vero IV. Hinc facies in una fronte foramen ad imponenda ligna et ignem, et, in latere uno, fenestram unius pedis ad inponendum et ejiciendum quod necessarium fuerit, et larem interius firmam et æqualem. Iste furnus dicitur clibanus refrigerii.

CAPUT III.

DE FURNO DILATANDI ET UTENSILIIS OPERIS.

FACIES etiam furnum tertium longitudine pedum sex, latitudine quatuor, altitudine trium, et foramen fenestramque et larem sicut superius. Hic furnus dicitur clibanus dilatandi et æquandi; utensilia vero ad hoc opus necessaria sunt fistula ferrea longitudine duarum ulnarum, grossitudine pollicis unius, forcipes duo in una parte ferri percussi, trullæ ferreæ duæ atque alia lignea et ferrea, quæ volueris.

you have thus arranged these things, make the interior part with the outer wall into the shape of an arched vault, in height, inside, rather more than half a foot, so that you make the hearth even throughout, outside, with a border three fingers high placed round it, that whatever work or utensil is placed upon it cannot fall off. This furnace is called the work oven.

CHAPTER II.

OF THE COOLING OVEN.

Make also another furnace, ten feet in length and eight in breadth, but in height four. Here make in one end an opening for introducing wood and fire, and in one side a window, of one foot, to place and withdraw whatever may be necessary; and a hearth inside, firm and smooth. This furnace is called the cooling oven.

CHAPTER III.

OF THE DILATING OVEN AND WORK TOOLS.

Make also a third furnace six feet in length, four in breadth, three in height, and an opening and window and hearth as above. This furnace is called the dilating and flattening oven. The utensils necessary for this work are, an iron pipe of two yards in length, of the thickness of a thumb; two pincers of iron beaten (flat) at one end; two iron trowels, and other wooden and iron utensils which you may wish.

CAPUT IV.

DE COMMIXTIONE CINERUM ET SABULI.

HIS ita compositis, accipe ligna faginea omnino in fumo exsiccata, et accende ignem copiosum in majori furno ex utraque parte. Deinde tollens duas partes cinerum de quibus supra diximus, et tertiam sabuli diligentur de terra et lapidibus purgati, quod de aqua tuleris, commisce in loco mundo. Cumque diu et bene commixta fuerint, levans cum trulla ferrea pone in minori parte furni super larem superiorem ut coquantur, et cum cœperint calefieri, statim eâdem trullâ move, ne forte liquefiant a calore ignis et conglomerentur, sicque facies per spatium unius noctis et diei.

CAPUT V.

DE VASIS OPERIS ET DE COQUENDO VITRO ALBO.

IN quo spatio accipe lutum album, ex quo componuntur ollæ, et exsiccans tere diligenter, et infusa aqua, macera cum ligno fortiter, et compone vasa tua, quæ sint superius lata, inferius vero stricta, habentia circa ora labium parvum interius recurvum. Quæ cum sicca fuerint, accipe cum forcipe ponens ea in foramine furni candentis ad hoc aptatâ, et levans cum trulla cineres coctos sabulo mixtos, imple omnia vasa vespere, et per totam noctem adde ligna sicca, ut vitrum ex cineribus et sabulo plenitur liquefactum coquatur.

CHAPTER IV.

OF THE MIXTURE OF ASHES AND SAND.

These being thus arranged, take beech-wood logs, completely dried in the smoke, and light a large fire in the larger furnace on both sides. Then taking two parts of the ashes, of which we have before spoken, and a third part of sand, carefully purged of earth and from the stones which you may have brought from the water, mix them in a clean place. When they have been long and well mixed together, taking them up with the iron trowel, place them in the smaller part of the furnace upon the upper hearth, so that they may be heated, and when they have begun to grow hot immediately stir them with the same trowel that they may not liquefy and be formed into a mass by the heat of the fire; and do this for the space of one night and day.

CHAPTER V.

OF THE WORK VASES AND OF HEATING WHITE GLASS.

During which time take white clay, of which jars are made, and, drying it, grind it carefully, and, pouring water upon it, beat it strongly with a piece of wood, and make your vases, which must be large at the top but small below, having a small lip round the mouth, curved inwardly. When they are dry take them with the pincers, placing them in the opening of the glowing furnace adapted for this, and with the trowel taking up the heated ashes mixed with sand, fill all the vases in the evening, and supply dry wood during the whole night, that the glass from the ashes and sand, being fully liquefied, may be cooked.

CAPUT VI.

QUOMODO OPERENTUR VITREÆ TABULÆ.

MANE autem hora prima accipe fistulam ferream, et si tabulas facere volueris vitreas, pone summitatem ejus in vas unum, vitro plenum; cui cum adhæserit, volve ipsam fistulam in manu tua donec conglomeretur circa eam, quantum volueris; moxque ejiciens appone ori tuo et suffla modicum, statimque removens ab ore tene juxta maxillam, ne forte, si retraxeris anhelitum, trahas flammam in os tuum. Habeas quoque lapidem æqualem ante fenestram super quem modice percuties ipsum candens vitrum, ut æqualiter ex omni parte pendeat, et statim cum festinatione crebro sufflans, totiens ab ore remove. Cumque videris illud quasi vesicam longam, adhibe summitatem ejus ad flammam, et statim liquefacto apparebit foramen, acceptoque ligno ad hoc opus apto, fac foramen amplum sicut est in medio. Deinde conjunge oram ipsius, superiorem videlicet partem ad inferiorem, ita ut ex utraque parte conjunctionis foramen appareat. Statimque cum humido ligno continge ipsum vitrum juxta fistulam, et excute modicum et separabitur. Mox etiam calefac ipsam fistulam in flamma fornacis, donec liquefiat vitrum quod ei jungitur, et cum festinatione pone super oras duas vitri conjunctas et adhærebit. Quod continuo elevans mitte in flamma fornacis donec liquefiat foramen unde prius fistulam separasti, et accepto ligno rotundo dilata illud sicut alterum et complicans oram ejus in medio separansque a fistula cum ligno humido, da puero, qui inducto ligno per foramen ejus portabit in furnum refrigerii, qui mediocriter calefactus sit. Hoc genus vitri purum est et album. Eodem modo atque eodem tempore operare similes partes vitri, donec vasa exhaurias.

CHAPTER VI.

HOW GLASS TABLETS ARE MADE.

In the morning, however, at the first hour, take the iron tube, and, if you wish to make plates of glass, place the end of it in a vase full of glass; when it has adhered to it, turn this tube round in your hand until as much as you may wish has accumulated around it; then, withdrawing it, bring it to your mouth and blow slightly, and instantly removing it from the mouth, hold it near your cheek, unless, in drawing breath, you may by chance attract the flame into your mouth. Have also a flat stone before the window upon which you beat this glowing glass a little, that it may hang equally on every side, immediately and with quickness, repeatedly blowing, so often you remove it from the mouth. When you see it look like a long bladder, bring the end of it towards the flame, and, being instantly melted, an opening will appear, and, the piece of wood fitted for this work being taken, make the opening as wide as is the glass in the middle. Then join its mouth together, namely, the upper to the lower part, so that on both sides of the junction an opening may appear. Instantly touch this glass near the tube with a moist piece of wood, shake it a little, and it will be separated. Presently also heat the tube in the flame of the furnace, until the glass attached to it liquefy, and, with rapidity, place it upon the two conjoined borders of glass, and it will adhere; directly taking this up, put it into the flame of the furnace until the opening, whence you formerly separated the tube, is liquefied, and the round piece of wood being taken, dilate it as the other, and folding together its mouth in the middle and separating it from the pipe with the moist wood, give it to the boy, who, introducing a piece of wood through the opening, will carry it to the cooling oven, which is made moderately warm. This kind of glass is pure and white. In the same manner, and at the same time, make similar pieces of glass until you exhaust the vases.

CAPUT VII.

DE CROCEO VITRO.

QUOD si videris vas aliquod in croceum colorem mutari, sine illud coqui usque horam tertiam, et habebis croceum leve, et operare inde quantum volueris ordine quo supra. Si autem vis permitte coqui usque ad horam sextam et habebis croceum rubicundum; fac etiam inde quod libuerit.

CAPUT VIII.

DE PURPUREO VITRO.

SI vero perspexeris quod se forte vas aliquod in fulvum colorem convertat, qui carni similis est, hoc vitrum pro membrana habeto, et auferens inde quantum volueris, reliquum coque per duas horas, videlicet a prima usque ad tertiam, et habebis purpuream levem, et rursum coctum a tertia usque ad sextam, erit purpura rufa atque perfecta.

CAPUT IX.

DE DILATANDIS VITREIS TABULIS.

CUM autem ex his coloribus operatus fueris quantum potueris, et vitrum in furno refrigeratum fuerit, expone universum opus tuum, et fac ignem copiosum accendi in furno in quo debet dilatari et æquari. Quo candente accipe ferrum calidum, et findens unam partem vitri, pone super larem candentis furni, et cum cœperit molliri, tolle forcipem ferreum et

CHAPTER VII.

OF YELLOW GLASS.

But if you see any vase changed into a yellow colour, allow it to heat until the third hour, and you will have a light yellow, and work from it as much as you wish in the above-mentioned order. If, however, you choose to allow it to be heated until the sixth hour, you will have a reddish yellow; make also from it what you please.

CHAPTER VIII.

OF PURPLE GLASS.

If you perceive that, by chance, any vase change itself into a tawny colour, which is like flesh, keep this glass for flesh tints, and taking from it as much as you want, heat the rest for two hours, namely, from the first until the third, and you will have a light purple; and again heated from the third until the sixth, it will be a red purple and perfect.

CHAPTER IX.

OF DILATING THE PLATES OF GLASS.

When you have made as much as you have been able from these colours, and the glass has become cold in the furnace, place out all your work and cause a large fire to be lighted in the furnace, in which it should be dilated and made flat. When glowing, take a hot iron, and, separating a part of the glass, place it upon the hearth of the glowing furnace, and, when it has begun to grow soft, take the iron forceps and

lignum æquale, aperiensque in ea parte qua fissum est, dilatabis et cum forcipe secundum libitum æquabis. Cumque omnino æquatum fuerit, mox ejiciens inde mitte in furnum refrigerii modice calefactum, sic ut non jaceat, sed stet ad parietem ejus tabula, juxta quam statues et aliam pari modo æquatam, ac tertiam et reliquas omnes. Quæ cum frigidæ fuerint, utere eis in componendis fenestris findendo particulatim qualiter volueris.

CAPUT X.

QUOMODO FIANT VASA DE VITRO.

VASA vero facturus compone vitrum ordine quo supra, et cum sufflaveris secundum quantitatem quam volueris, non facies foramen in fundo sicut superius, sed integrum ita separabis a fistula cum ligno aquæ intincto, quam fistulam mox calefactam adhærere facies in ipso fundo. Elevans vero vas, calefacies in flamma, et cum ligno rotundo dilatabis foramen illud unde fistulam[1] secundum libitus tuos, amplificabisque circa fistulam fundum ut inferius cavum sit. Quod si volueris ansas in eo facere, quibus possit pendere, accipe gracile ferrum, et mittens illud summotenus in vas vitri, cum ei modicum adhæserit, auferens pone super vas, in quo loco placuerit, et cum adhæserit, calefacies ut firmiter hæreat. Fac ex his ansis quod velis, interim tenens vas juxta flammam ut calidum sit nec tamen liquescat. Aufer etiam modicum vitri a furno ita ut filum post se trahat, et adponens vasi in quo loco volueris, circumvolve juxta flammam ut adhæreat. Quo facto secundum consuetudinem amovebis fistulam, mittens vas in furnum refrigerii; atque hoc modo operaberis, quantum velis.

[1] "separasti," *C. Guelpher.*

smooth piece of wood, and, opening it in that part in which is the division, you will dilate and smooth it according to your will with the pincers. When it has become quite smooth, immediately taking it out, place it in the cooling oven, moderately warmed; and so that the plate may not lie down, but stand against the wall, next to which you will place another, also flattened in the same manner, and a third; also all the rest. When these have become cold, use them in composing windows, by separating them into pieces as you wish.

CHAPTER X.

HOW VASES ARE MADE FROM GLASS.

In order to make vases, compose the glass in the furnace in the above manner, and when you have blown according to the quantity you wish, you must not make an opening at the end, as before, but you will detach it from the tube, entire as it is, with the wood moistened with water; then make the tube, warmed, adhere to the bottom itself. Raising the vase, warm it in the flame, and you will dilate that opening, whence you separated the tube, with the round piece of wood, according to your desire; you will also enlarge the bottom around the tube so that the lower part may be hollow. But if you wish to make handles to it, by which it may hang, take a thin piece of iron, and, immersing it in the pot of glass, when a little has stuck to it, raising it, place it upon the vase, in whatever place it may please you; and when it has adhered, heat it, so that it may fasten firmly. Make of these handles what you please, in the mean time keeping the vase near the flame, so that it may be hot, yet not liquefy. Take also a little glass from the furnace, so that it may draw a thread after it, and placing it upon the vase in what place you wish, revolve it near the flame, that it may adhere. Which being done, you will remove the tube according to custom, placing the vase in the cooling oven; and you will work in this fashion as much as you desire.

CAPUT XI.

DE AMPULLIS CUM LONGO COLLO.

QUOD si volueris ampullas cum longo collo facere, sic age. Cum sufflaveris calidum vitrum quasi vesicam magnam, obstrue foramen fistulæ pollice tuo, ne forte ventus exeat, vibrans ipsam fistulam cum vitro, quod ei appendet, ultra caput tuum, eo modo quasi velis eam projicere, et mox extenso collo ejus in longum, elevata manu tua in altum, sine fistulam cum vase inferius dependere, ut collum non curvetur, et sic separans cum humido ligno mitte in furnum refrigerii.

CAPUT XII.

DE DIVERSIS VITRI COLORIBUS NON TRANSLUCIDIS.

INVENIUNTUR in antiquis ædificiis Paganorum in musivo opere diversa genera vitri; videlicet album, nigrum, viride, croceum, saphireum, rubicundum, purpureum, et non est perspicax, sed densum in modum marmoris, et sunt quasi lapidi[1] quadri, ex quibus fiunt electra in auro, argento et cupro, de quibus in suo loco sufficienter dicemus. Inveniuntur etiam vascula diversa eorundem colorum, quæ colligunt Franci in hoc opere peritissimi, et saphireum quidem fundunt in furnis suis, addentes ei modicum vitri clari et albi, et faciunt tabulas saphiri pretiosas ac satis utiles in fenestris. Faciunt etiam ex purpura et viridi similiter.

[1] *In codice Guelph.* "lapilli."

CHAPTER XI.

OF FLASKS WITH A LONG NECK.

But if you wish to make flasks with a long neck act thus. When you have blown the hot glass in the form of a large bladder, close the opening of the tube with your thumb so that the air may not escape, swinging the tube, with the glass which hangs from it, above your head, in such a manner as if you wished to throw it off, and presently, its neck being extended in length, your hand being raised upright, allow the tube, with the vase below it, to hang down, that the neck may not become curved; and thus separating it with a moist piece of wood, place it in the cooling oven.

CHAPTER XII.

OF DIVERS COLOURS OF GLASS, NOT TRANSPARENT.

In the ancient edifices of the Pagans, different kinds of glass are found in mosaic work, namely, white, black, green, yellow, sapphire, red, and purple; it is not clear, but opaque, like marble, and they are like square stones; from which coloured gems are made in gold, silver, and brass work, of which we speak fully in their proper place. Divers small vases are also found, of the same colours, which the French, most intelligent in this work, collect, and some melt the sapphire in their furnaces, adding to it a little clear and white glass, and make costly plates of sapphire, and very useful in windows. They work also from the purple and green in a similar manner.

CAPUT XIII.

DE VITREIS CYPHIS, QUOS GRÆCI AURO ET ARGENTO DECORANT.

GRÆCI vero faciunt ex eisdem saphireis lapidibus pretiosos cyphos ad[1] potandum, decorantes eos auro hoc modo. Accipientes auri petulam, de qua superius diximus, formant ex ea effigies hominum, aut avium, aut bestiarum, vel foliorum, et ponunt eas cum aqua super cyphum in quocumque loco voluerint; et hæc petula debet aliquantulum spissior esse. Deinde accipiunt vitrum clarissimum, velut crystallum, quod ipsi componunt, quodque mox, ut senserit calorem ignis, solvitur, et terunt diligenter super lapidem porphiriticum cum aqua, ponentes cum pincello tenuissime super petulam per omnia, et cum siccatum fuerit, mittunt in furnum, in quo fenestræ vitrum pictum coquitur, de quo postea dicemus, supponentes ignem et ligna faginea in fumo omnia siccata. Cumque viderint flammam cyphum tandiu pertransire donec modicum ruborem trahat, statim ejicientes ligna, obstruunt furnum, donec per se frigescat, et aurum nunquam separabitur.

CAPUT XIV.

ITEM UNDE SUPRA.

FACIUNT et alio modo, accipientes aurum in molendino molitum, cujus usus est in libris, temperant aqua, et argentum similiter, facientes inde circulos et in eis imagines, sive bestias, aut aves, opere variato, et liniunt hæc vitro lucidissimo, de quo supra diximus. Deinde accipientes vitrum album et rubicundum ac viride, quorum usus est in electris, terunt super lapidem porphiriticum unumquodque per se diligenter cum aqua, et inde pingunt flosculos et nodos,

[1] "portandum," *vitiosè in MS. Harl. in cæteris, ut supra.*

CHAPTER XIII.

OF THE GLASS CUPS WHICH THE GREEKS ORNAMENT WITH GOLD AND SILVER.

THE Greeks indeed make from the same sapphire stones precious drinking cups, decorating them with gold in this manner. Taking gold leaf, of which we have before spoken, they form from it the likeness of men, or birds, or beasts, or leaves, and place them, with water, upon the cup in whatever place they wish, and this leaf should be somewhat thicker (than usual). Then they take a very clear glass, like crystal, which they themselves compose, which as soon as it feels the heat of the fire dissolves, and grind it carefully upon a porphyry stone with water, laying it very thinly with a pencil over all the leaf, and, when it is dry, they place it in the furnace in which the painted glass of windows is heated, of which we shall speak afterwards, supplying fire from beechwood, perfectly dried in the smoke. And when they see the flame penetrate the cup, until at length it shows a slight red colour, instantly withdrawing the wood, they close the furnace, until it cool by itself, and the gold will never be detached.

CHAPTER XIV.

THE SAME AS THE PRECEDING.

THEY do it also in another manner; taking gold ground in a mill, which is used in books, they temper it with water, (and silver likewise,) painting small circles with it, and in them figures, or animals, or birds, in varied work, and they cover these with the very clear glass of which we have previously spoken. Then taking glass, white, red and green, which is used in artificial gems, they grind each one by itself upon the porphyry stone carefully, with water, and then they paint little flowers and flourishes and other small things which they

aliaque minuta, quæ voluerint, opere vario inter circulos, et limbum circa oram; et hoc mediocriter spissum, coquentes in furno ordine quo supra. Faciunt quoque cyphos ex purpura sive levi saphiro, et fialas, mediocriter extento collo circumdantes filis ex albo vitro factis, ex eodem ansas imponentes. Ex aliis etiam coloribus variant diversa opera sua pro libitu suo.

CAPUT XV.

DE VITRO GRÆCO, QUOD MUSIVUM OPUS DECORAT.

VITREAS etiam tabulas faciunt opere fenestrario ex albo vitro lucido, spissas ad mensuram unius digiti, findentes eas calido ferro per quadras particulas minutas, et co-operientes eas in uno latere auri petula, superliniunt vitrum lucidissimum tritum ut supra. Hujusmodi vitrum interpositum musivum opus omnino decorat.

CAPUT XVI.

DE VASIS FICTILIBUS DIVERSO COLORE VITRI PICTIS.

SCUTELLAS quoque fictiles et naviculas faciunt, aliaque vasa fictilia, pingentes ea hoc modo. Accipiunt omnium genera colorum, terentes ea singillatim cum aqua, et ad unumquemque colorem miscentes ejusdem coloris vitrum per se minutissime tritum cum aqua, quintam partem, inde pingunt circulos sive arcus vel quadrangulos, et in eis bestias, aut aves, sive folia vel aliud quodcumque voluerint. Postquam vero ipsa vasa tali modo depicta fuerint, mittunt ea in furnum

please, with varied work, within the circles, and a border round the mouth; and this moderately thick, heating in the furnace in the order above mentioned. They make also cups from purple or light sapphire, and small bottles with a neck moderately long, surrounding them with threads made from white glass, placing handles of the same upon them. They vary also their divers works with other colours according to their will.

CHAPTER XV.

OF GREEK GLASS WHICH ORNAMENTS MOSAIC WORK.

They make also glass tablets, as in window work, from transparent white glass, of the thickness of a finger, dividing them with a hot iron into small square pieces; and covering them on one side with gold leaf, they paint over it the very clear glass, ground, as above mentioned. This kind of glass, placed among mosaic work, adorns it exceedingly.

CHAPTER XVI.

OF EARTHENWARE VASES, PAINTED IN DIVERS COLOURS OF GLASS.

They likewise make earthenware basins and small vessels and other fictile vases, painting them in this manner. They take all kinds of colours, grinding them singly with water; and mixing with each colour a fifth part glass of the same colour, very finely ground by itself with water, they paint with it circles or arches or squares, and in them beasts, birds, or leaves, or any other thing they may wish. After these vases have been painted in this manner, they place them in the fur-

fenestrarum, adhibentes inferius ignem atque ligna faginea sicca, donec a flammis circumdata, sicque extractis lignis furnum obstruunt. Possunt etiam eadem vasa per loca decorari auri petula, sive molito auro vel argento, modo quo supra, si voluerint.

CAPUT XVII.

DE COMPONENDIS FENESTRIS.

CUM volueris fenestras componere vitreas, primum fac tibi tabulam ligneam æqualem tantæ latitudinis et longitudinis, ut possis unius cujusque fenestræ duas partes in ea operari, et accipiens cretam atque radens cum cultello per totam tabulam, asperge desuper aquam per omnia, et frica cum panno per totum. Cumque siccata fuerit, accipe mensuram unius partis in fenestra longitudinem et latitudinem, pingens eam in tabula regulâ et circino cum plumbo vel stagno, et si vis limbum in ea habere, pertrahe cum latitudine qua tibi placuerit, et opere quo volueris. Quo facto pertrahe imagines quot volueris in primis plumbo vel stagno, sicque rubeo colore sive nigro, faciens omnes tractus studiose, quia necessarium erit cum vitrum pinxeris, ut secundum tabulam conjungas umbras et lumina. Deinde disponens varietates vestimentorum, nota uniuscujusque colorem in suo loco; et aliud quodcumque pingere volueris una littera colorem signabis. Post hæc accipe vasculum plumbeum, et in eo mitte cretam cum aqua tritam, fac tibi pincellos duos vel tres ex pilo, videlicet ex cauda mardi, sive grisii, vel spirioli, aut catti, sive de coma asini; et accipe unam partem vitri cujuscumque generis volueris, quæ ex omni parte major sit loco in quo ponenda est, adhibens eam campo ipsius loci, et sicut consideraveris tractus in tabula per medium vitrum, ita pertrahe cum

nace used for window (glass), and applying a fire of dry beech-wood below them until they are surrounded by the flame; and thus, the wood being taken out, they close the furnace. The same vases can also be decorated in places with gold leaf, or with ground gold or silver, if they wish, in the above mentioned manner.

CHAPTER XVII.

OF COMPOSING WINDOWS.

When you wish to compose glass windows, first make for yourself a flat wooden table, of such breadth and length that you can work upon it two portions of the same window; and taking chalk, and scraping it with a knife over all the table, sprinkle water everywhere, and rub it with a cloth over the whole. And when it is dry, take the dimensions of one portion of the window in length and breadth, marking it upon the table with rule and compass with the lead or tin; and if you wish to have a border in it, portray it with the breadth which may please you, and in the pattern you may wish. Which done, draw out whatever figures you will, first with the lead or tin, then with a red or black colour, making all outlines with study, because it will be necessary, when you have painted the glass, that you join together the shadows and lights according to the (drawing on the) table. Then arranging the different tints of draperies, note down the colour of each one in its place; and of any other thing which you may wish to paint you will mark the colour with a letter. After this take a leaden cup, and put chalk, ground with water, into it: make two or three pencils for yourself from hair, either from the tail of the marten, or badger, or squirrel, or cat, or the mane of the ass, and take a piece of glass of whatever kind you like, which is in every way larger than the place upon which it is superposed, and fixing it in the ground of this place, so that you can perceive the drawing upon the table through the glass, so portray with the chalk the outlines

creta super vitrum exteriores tractus tantum. Et si vitrum illud densum fuerit sic ut non possis perspicere tractus qui sunt in tabula, accipiens album vitrum pertrahe super eum, atque cum siccum fuerit pone densum vitrum super album elevans contra lucem, et sicut perspexeris, ita pertrahe. Eodem modo designabis omnia genera vitri sive in facie, sive in vestimentis, in manibus, in pedibus, in limbo, vel in quocumque loco colores ponere volueris.

CAPUT XVIII.

DE DIVIDENDO VITRO.

POSTEA calefacies in foco ferrum divisorium, quod sit per omnia gracile, sed in fine grossius. Quod cum canduerit in grossiori parte, adpone vitro, quod dividere volueris, et mox apparebit initium fracturæ. Si vero vitrum durum fuerit, madefac illud digito tuo ex saliva in loco, ubi ferrum posueras; quo statim fisso, secundum quod dividere volueris, trahe ferrum et fissurâ sequetur. Omnibus vero partibus ita divisis, accipe grosarium ferrum, quod sit longitudine unius palmi, utroque capite recurvum, cum quo æquabis et conjunges omnes partes, unamquamque in suo loco. His ita compositis accipe colorem cum quo vitrum pingere debes, quem tali modo compones.

CAPUT XIX.

DE COLORE CUM QUO VITRUM PINGITUR.

TOLLE cuprum tenuè percussum, comburens in parvula patella ferrea donec pulvis omnino sit, et accipe parti-

upon the glass. And if the glass should be so thick that you cannot perceive the lines which are upon the table, taking white glass, draw upon it, and when it is dry place the thick glass upon the white, raising it against the light, and as you look through it, so portray it. In the same manner you will mark out all kinds of glass, whether for the face, or in draperies, in hands, in feet, in the border, or in whatever place you intend to place colours.

CHAPTER XVIII.

OF DIVIDING GLASS.

Afterwards heat in the fire the dividing iron, which should be thin throughout, but thicker at the end. When it glows in the thick part apply it to the glass which you wish to divide, and presently the commencement of a small fissure will appear. If, however, the glass be hard, wet it with saliva, with your finger, in the spot where you place the iron; being instantly cracked, draw the iron along where you wish to divide, and it is followed by the fissure. All the portions being thus divided, take the riesel iron, which is a palm in length, curved at each extremity, with which you will equalize and join all parts together, each one in its place. These things being thus arranged, take the colour with which you should paint the glass, which you compose in this manner.

CHAPTER XIX.

OF THE COLOUR WITH WHICH GLASS IS PAINTED.

Take copper beaten thinly, burning it in a small iron cup until it is quite in a powder, and take particles of green glass

culas viridis vitri, et saphiri Græci, terens singulariter inter duos lapides porfiriticos, et commiscens hæc tria simul, ita ut sit tertia pars pulvis, et tertia viride, tertiaque saphirum, teres pariter super ipsum lapidem cum vino vel urina diligentissime, et mittens in vas ferreum sive plumbeum, pinge vitrum cum omni cautela secundum tractus, qui sunt in tabula. Quod si litteras in vitro facere volueris, partes co-operies omnino ipso colore, scribens eas cauda pincelli.

CAPUT XX.

DE TRIBUS COLORIBUS AD LUMINA IN VITRO.

UMBRAS et lumina vestimentorum, si studiosus fueris in hoc opere, poteris eodem modo facere, sicut in pictura colorum, tali modo. Cum feceris tractus in vestimentis ex colore prædicto, sparge eum cum pincello ita ut vitrum fiat perspicax in ea parte, qua luminam facere consuesti in pictura, et idem tractus in una parte sit densus, in altera levis, atque levior cum tanta diligentia discretus, quasi videantur tres colores appositi. Quem ordinem observare ita debes, infra supercilia, et circa oculos atque nares et mentum, ac circa facies juvenum, cirça pedes nudos et manus et reliqua membra corporis nudi, sitque species picturæ composita colorum varietate.

CAPUT XXI.

DE ORNATU PICTURÆ IN VITRO.

SIT etiam quidam ornatus in vitro, videlicet in vestibus, in sedibus, et in campis, in saphiro, in viridi et albo, purpureoque colore claro. Cum feceris priores umbras in hujusmodi vestibus, et siccæ fuerint, quicquid reliquum est

and of Greek sapphire, grinding them singly between two porphyry stones, and, mixing these three things together, so that a third part may be powder, a third green, and a third sapphire, grind them together upon the same stone, very carefully, with wine or urine, and putting it into an iron or leaden vessel, paint the glass, with great care, according to the lines which are upon the table. But if you wish to make letters upon the glass, cover the parts all over with this same colour, writing them with the handle of the pencil.

CHAPTER XX.

OF THE THREE TINTS FOR ILLUMINATING UPON GLASS.

If you would be earnest in this work, you can, in the same manner as in a coloured picture, make the shadows and lights of draperies in this way. When you have made the drawing in the drapery of the aforesaid colour, spread it with the pencil, so that the glass may be made clear in that part in which you are accustomed to make the light in a picture; and let this drawing be in one place thick, in another light, and yet lighter, separated with such care that three tints may seem applied. Which arrangement you should thus observe, below the eyebrows and about the eyes, the nostrils and chin, and about the faces of young people, about the naked feet and hands, and the other members of the nude: and this kind of picture must be composed with a variety of tints.

CHAPTER XXI.

OF THE EMBELLISHMENT OF A PICTURE IN GLASS.

There is likewise a certain ornamenting upon glass, namely, in garments, in seats, and in grounds, in sapphire, green, white, and light purple colour. When you have made the first shadows in drapery of this kind, and they have become

vitri, co-operi levi colore, qui non sit tam densus sicut secunda umbra, nec tam clarus sicut tertia, sed inter has medius. Quo exsiccato fac cum cauda pincelli juxta umbras priores, quas feceras, subtiles tractus ex utraque parte, ita ut inter hos tractus[1] umbras illius levis coloris subtiles tractus remaneant. In reliquo autem fac circulos et ramos, et in eis flores ac folia eodem modo, quo fiunt in litteris pictis; sed campos qui coloribus implentur in litteris, debes in vitro subtilissimis ramusculis pingere. Potes etiam in ipsis circulis interdum bestiolas et avicolas, vermiculos que ac nudas imagines inserere. Eodem modo facies campos ex albo clarissimo, cujus campi imagines vesties cum saphiro, viridi, purpura, et rubicundo. In campis vero saphiri et viridis coloris eodem modo depictis, et rubicundi non picti, facies vestimenta ex albo clarissimo, quo vestimenti genere nullum speciosius est. Ex supra dictis tribus coloribus pinges in limbis ramos et folia, flores et nodos, ordine quo supra; et uteris eisdem in vultibus imaginum et manibus ac pedibus et in nudis membris per omnia pro eo colore, qui in præcedenti libro dicitur posc. Croceo vitro non multum uteris in vestimentis nisi in coronis et in eis locis ubi aurum ponendum esset in pictura. His omnibus ita compactis ac depictis coquendum est vitrum et color confirmandus in furno quem compones hoc modo.

CAPUT XXII.

DE FURNO IN QUO VITRUM COQUITUR.

ACCIPE virgas flexibiles infigens eas terræ in angulo domus, utroque capite æqualiter in similitudinem arcuum, qui arcus habeant altitudinem pedis et dimidii, lati-

[1] *Cod. Guelph.* "et priores" *interpon.*

dry, cover whatever of the glass is left with a light colour, which must not be so dark as the second shadow, nor so light as the third, but the mean between these. Which being dry, with the reverse of the pencil make, next the first shadows which you made, fine lines on each side, so that, between these tints, and the [1] shadows, fine lines of that light colour may exist. But upon the remainder make circles and branches, and upon them flowers and leaves, in the same manner as they are made in painted letters; but upon grounds which are filled with letters in colours, you should paint upon the glass with the most delicate small branches. You can also sometimes insert in the same circles small animals and little birds, small insects and nude figures. In the same manner you make grounds of the clearest white, the figures of which grounds you ornament with sapphire, green, purple, and red. Also in grounds of blue and green colour, painted over in the same manner, and of red not painted, you make draperies of the clearest white, than which kind of garment none is more beautiful. From the above-named three colours you paint boughs and leaves in borders, flowers and intricacies, in the above order; and you will use the same (colour) in the faces of figures and in the hands and feet, and everywhere in the nude members, for that colour which, in the preceding book is called posc. You will not make much use of yellow glass in draperies, unless in crowns and in those places where gold is placed in a painting. All these things being thus composed and painted, the glass is to be heated, and the colour fixed in the furnace, which you make in this manner.

CHAPTER XXII.

OF THE FURNACE IN WHICH GLASS IS BURNT.

Take flexible rods, fixing them in the earth in an angle of the house at both ends equally in the form of arches, which arches may have the height of a foot and a half, and also a

[1] In the codex of Wolfenbüttel the word "first" is here inserted.

tudinem quoque similem, longitudinem vero modice amplius duorum pedum. Deinde macerabis argillam fortiter cum aqua et fimo equi, ita ut tres partes sint argilla, et quarta fimus. Qua optimè macerata, miscebis ei fœnum siccum, faciens inde pastillos longos et co-operies arcum virgarum interius et exterius ad spissitudinem unius pugni, et in medio superius relinques foramen rotundum per quod possis manum tuam imponere; facies etiam tibi tres trabes ferreos grossitudine unius digiti, et longitudine tantâ ut possint transire latitudinem furni, quibus facies ex utraque parte tria foramina, ut cum volueris possis imponere et ejicere. Tunc pones in furnum ignem et ligna donec exsiccetur.

CAPUT XXIII.

QUOMODO COQUATUR VITRUM.

INTERIM fac tibi tabulam ferream ad mensuram furni interius, exceptis duobus digitis in longitudine et duobus in latitudine, super quam cribrabis calcem vivum, sive cineres spissitudine unius festucæ, et cum æquali ligno[1] ut firmiter jaceant. Habebit eadem tabula caudam ferream, per quam possit portari et imponi ac extrahi. Pones autem super eam vitrum pictum diligenter et conjunctum, ita ut in exteriore parte versus caudam ponas viride et saphirum, ac interius album croceum et purpureum, quod durius est contra ignem, et sic immissis trabibus pones super eos tabulam. Deinde accipes ligna faginea in fumo valde sicca, et accendes ignem modicum in furno, postea majorem cum omni cautela, donec videas flammam retro, et ex utraque parte inter furnum et tabulam ascendere, et vitrum transiendo atque quasi lingendo co-operire, tamdiu donec candescat; et statim ejiciens ligna

[1] *MS. Guelph.* "compones eos," *additur.*

similar breadth and a length of a little more than two feet. You will then beat up clay strongly with water and horse litter, so that three parts may be clay and a fourth dung. With which, being well beaten together, you will mix dry hay, making of it long flat pieces, and you will cover the arch of rods, inside and outside, to the thickness of a fist, and in the middle above you leave a round opening through which you can put your hand; make for yourself also three iron bars of the thickness of a finger, and of such length that they may traverse the breadth of the furnace, in which, on both sides, make three holes, so that you can place and withdraw them when you wish. Then place fire and wood in the furnace until it is dried.

CHAPTER XXIII.

HOW GLASS MAY BE BURNT.

In the mean time make an iron tablet for yourself of the size of the furnace inside, two fingers in length and two in breadth excepted, upon which you will sift quick-lime, or (wood) ashes, the thickness of a straw, and[1] (arrange them) with a flat piece of wood that they may lie firmly. The same tablet will have an iron handle by which it can be carried and placed and withdrawn. Lay the painted glass carefully upon it, joined together so that on the outer part, towards the handle, you place the green and sapphire, and on the inner the white, yellow, and purple, which is the most resisting against the fire, and thus, the bars being put in, place the tablet upon them. Then take beech wood, well dried in the smoke, and light a small fire in the furnace, afterwards larger, with great precaution, until you see the flame rise at the back and on both sides between the furnace and the tablet, and by passing over the glass cover it, as if in licking it, until at length it glows; immediately withdrawing the wood, carefully close the mouth

[1] From the Wolfenbüttel MS.

obstrues os fornacis diligenter, ac superius foramen per quod fumus exibat, usque dum per se refrigeret. Ad hoc valet calx et cinis super tabulam, ut servet vitrum, ne super nudum a calore confringatur. Ejecto autem vitro proba, si possis cum ungue tuo colorem erodere; si non, sufficit ei, sin autem, iterum repone. Tali modo partibus omnibus coctis, repone super tabulam singulas in suo loco; deinde funde calamos ex puro plumbo hoc modo.

CAPUT XXIV.

DE FERRIS INFUSORIIS.

FAC tibi duos ferros, latitudine digitorum duorum et spissitudine unius digiti, longitudineque unius ulnæ. Hos copulabis in una summitate in modum cardinum ut sibi adhæreant, et uno clavo firmentur, ita ut possint claudi et aperiri, et in altero capite aliquantulum latiores et tenuiores ita, ut cum clauduntur, sit quasi initium foraminis interius, et exteriores costæ æqualiter procedant; sicque conjunges eos cum lima, ut nihil luminis inter eos perspicere possis. Post hæc separabis eos ab invicem, acceptaque regula tua facies in medio unius partis duas lineas, et e contra in medio alterius duas, a summo usque deorsum parva latitudine, et fodies eos ferro fossorio, quo candelabra fodiuntur, quam profunde volueris, et rade interius inter duas regulas modicum in utroque ferro, ut cum plumbum in eis fuderis, una pars fiat. Os vero, in quod funditur, ita ordinabis, ut una pars ferri jungatur in alteram, ne possit in fundendo vacillare.

of the furnace and the upper opening through which the smoke escaped, until it cool by itself. The lime and ashes upon the tablet are useful for this, to preserve the glass, that it may not be broken upon the bare (iron) by the heat. The glass being taken out, assay if you can scrape off the colour with your nail; if not, it is sufficient for it, but if you can, replace it again. All the pieces being burnt in this manner, relay each in its place upon the table; then found the rods from pure lead in this manner.

CHAPTER XXIV.

OF THE IRON MOULDS.

MAKE for yourself two irons, in breadth two fingers, and one finger in thickness, and a yard in length. You will join these together at one end like a hinge, that they may adhere together and be fastened by a nail, so that they can be shut and opened; and let them be rather wider and thinner at the other end, so that when they are shut there may be like the beginning of an inside cavity, and let the outer sides project evenly, and so join them together with the file that you may be unable to perceive any light between them. Afterwards you will separate them from one another, and, taking your rule, make two lines in the middle of one piece, and two in the middle of the other opposite, small in breadth from top to bottom, and hollow them out with the chasing iron, with which lamps are hollowed out, as deep as you wish, and rasp a little inside between the two lines in both pieces of iron, so that when you pour the lead into them one piece may be made. But you will so arrange the mouth into which it is poured, that one part of the iron may be coupled to the other, that it cannot slip during the casting.

CAPUT XXV.

DE FUNDENDIS CALAMIS.

POST hæc fac tibi larem ubi plumbum fundas, et in lare fossam in quo ponas testam ollæ magnam, quam linies interius et exterius argillâ cum fimo maceratâ ut firmior sit, et super eam accendes ignem copiosum. Cumque siccata fuerit, pone plumbum super ignem intra testam, ut cum liquefactum fuerit fluat in eam. Interim aperiens ferrum calami pone super carbones, ut calidum fiat, et habeas lignum longitudinis unius ulnæ, quod sit in uno capite, quo manu tenebitur, rotundum, in altero vero planum et latum ad mensuram quatuor digitorum, ubi incidatur in transverso usque in medium secundum latitudinem ferri, in quam incisuram ipsum ferrum calidum et in se clausum pones, et ita in superiori parte manu modicum reflexâ tenebis, ut inferiori parte super terram stet, acceptaque parvula patella ferrea calefacta, hauri liquefactum plumbum et funde in ferrum. Et statim depone patellam super ignem ut semper sit calida, ejectumque ferrum a ligno super terram aperi cum cultello, et eiciens, calamum rursum claude et repone in lignum. Si autem non possit plumbum ferro funditus influere, calefacto melius ferro iterum funde; sicque temperabis donec plenum fiat, quia, si æqualiter temperatum fuerit, in uno calore plus quam quadraginta calamos fundere poteris.

CAPUT XXVI.

DE LIGNO INFUSORIO.

QUOD si ferrum non habueris, perquire tibi lignum abietinum vel aliud, quod æqualiter findi possit, longitudinis, latitudinis et spissitudinis ut supra, quod fissum incide

CHAPTER XXV.

OF CASTING THE RODS.

After these things make a hearth for yourself where you can melt lead, and in the hearth a hollow, in which you can place a large earthen vessel, which you line inside and out with clay beat up with dung, that it may be the more firm, and light a large fire over it. And when it has become dry place the lead upon the fire inside the pot, that, when it is liquefied, it may flow into it. In the mean time, opening the rod-mould, place it over the charcoal, so that it may become warm; and you must have a piece of wood a yard in length, which is round at the end which is held in the hand, but at the other flat and wide, to the size of four fingers, where it is cut across as far as the centre, according to the breadth of the iron, in which incision you place this mould hot and closed together, and you will so hold it in the upper part with the hand slightly bent back, that, in the lower part, it may stand upon the ground, and taking the small iron spoon warmed, take out the liquefied lead, and pour it into the mould: and immediately place the spoon upon the fire, that it may be always warm, and casting the mould from the wood upon the ground, open it with a knife, and taking out the rod again, shut it and replace it in the wood. If, however, the lead is not able to flow in the mould to the bottom, cast again in the better warmed mould, and you will regulate it so that it may become full, because if it becomes all of an equal temperature, you can cast more than forty rods with one heating.

CHAPTER XXVI.

OF THE MOULD IN WOOD.

But if you have not iron, seek for yourself fir, or other wood which can be smoothly divided, of the length, breadth, and thickness as above, which being cleft, cut the outside

exterius rotundum. Deinde ordinabis duo signa parvula exterius in utraque utriusque ligni fronte, secundum quod volueris calamum latum esse in medio, accipiensque filum lineum retortum et gracile, madefac illud in rubeo colore, disjunctisque lignis, super unam partem interius appone ipsum filum, a signo quod incidisti superius, usque ad signum inferius, ita ut firmiter extendatur, et adjungens illi alterum lignum fortiter comprime, ita ut cum separaveris color in utrisque partibus appareat. Ejectumque filum et rursum colore madidum affige in alterum signum, iterumque super pone aliud lignum et comprime. Cumque in utrisque partibus color apparuerit, incide cultello calamum, quam latum et profundum volueris, sic tamen ut incisura finem non pertranseat, sed superius, ubi infundi debet, foramen habeat. Quo facto ligna conjunge, ligans cum corrigia a summo usque deorsum, et tenens cum ligno infunde plumbum, solutaque corrigia eice calamum. Rursumque ligans et infundens, hoc tam diu facies, donec ustura usque ad finem incisuræ perveniat; sicque postea leviter, quoties et quantum volueris infundere poteris. Cumque tibi sufficere calamos videris, incide lignum duobus digitis latum et tam spissum sicut calamus est interius, dividens illud in medio ita, ut in una fronte integrum sit et in altera incisum ubi calamus inferatur. Quem impositum incide cum cultello ex utraque parte, et plana et rade sicut placuerit.

CAPUT XXVII.

DE CONJUNGENDIS ET CONSOLIDANDIS FENESTRIS.

HIS ita compositis accipe stagnum purum et commisce ei quintam partem plumbi, et funde in supradicto ferro sive ligno quot calamos volueris cum quibus opus tuum solidabis. Habeas quoque clavos quadraginta longitudine unius digiti, qui sint in uno capite graciles et rotundi, in

round. You will then fashion two small marks outside at each end of each piece of wood, according to the width which you wish the rod to be between, and taking a flaxen thread thin and twisted, moisten it in red colour, and, separating the pieces of wood, apply this cord upon one inside surface, from the mark which you cut at the top to the mark below, so that it may be firmly stretched; and joining the other wood to it press them together strongly, so that when you have separated them the colour may appear upon both pieces. The thread, being taken off and again moistened with colour, is fixed upon the other mark, and you place the other wood upon it and compress it. When the colour shall have appeared upon both sides, cut the groove with a knife as wide and deep as you wish, so, however, that the incision may not pass through the lower end, but at the top, where you pour in, it may have an opening. Which being done, join the woods together, binding them with a strap from top to bottom, and holding it with the wood, pour in the lead, and the strap being loosened, take out the rod. Again binding and casting, do this until at length the burning reaches the bottom of the incision; and so you can afterwards cast, gently, as often and as many as you wish. When you see that you have rods enough, cut a piece of wood two fingers wide and as thick as the groove is inside, dividing it in the middle so that at one end it is whole, and at the other there is an incision, in which the rod is inserted. Cut which, placed in it, with a knife on both sides, and smooth and scrape it as it may please you.

CHAPTER XXVII.

OF UNITING TOGETHER AND SOLDERING WINDOWS.

These things being thus arranged, take pure tin and mix with it a fifth part of lead, and cast in the above mentioned iron or wood as many rods as you wish, with which you will solder your work. Have also forty nails a finger in length, which are at one end fine and round, at the other square, and

altero quadri et recurvi penitus, ita ut foramen appareat in medio. Deinde accipe vitrum pictum et coctum et pone secundum ordinem in altera parte tabulæ ubi nulla est pictura. Post hæc tolle caput unius imaginis, et circumvolvens illud plumbo repone diligenter in suo loco, et circumfige ei tres clavos cum malleo ad hoc opus apto, adjungens ei pectus et brachia ac reliqua vestimenta; et quamcumque partem stabilieris, confirma eam exterius clavis, ne moveatur a suo loco. Tunc habeas ferrum solidatorium, quod sit longum et gracile, in summitate vero grossum ac rotundum, et in summo ipsius rotunditatis deductum et gracile, limatum et superstannatum, ponaturque in ignem. Interim accipe calamos stagneos quos fudisti, et perfunde eos cerâ ex utraque parte, et radens plumbum in superficie per omnia loca, quæ solidanda sunt. Accepto ferro calido appone ei stagnum, in quocumque loco duæ partes plumbi conveniunt, et cum ferro linies donec sibi adhæreant. Statutis vero imaginibus eodem modo ordinabis campos cujuscumque coloris volueris, et sic particulatim compones fenestram tuam. Perfecta vero fenestra et in uno latere solidata, conversam in aliud simili modo radendo et solidando firmabis per omnia.

CAPUT XXVIII.

DE GEMMIS PICTO VITRO IMPONENDIS.

IN imaginibus vero fenestrarum si volueris in crucibus, vel in libris, aut in ornatu vestimentorum, super pictum vitrum gemmas facere alterius coloris absque plumbo, videlicet iacinctos et smaragdos, hoc modo agas. Cum feceris cruces in suis locis in capite majestatis, aut librum, sive ornamenta in fine vestium, quæ in pictura fiunt ex auro sive ex auripigmento, hæc in fenestris fiant ex croceo vitro claro.

quite curved back, so that an opening may appear in the middle. Then take the painted and burnt glass, and place it in its order upon the other part of the table, where there is no drawing. After that take the head of any one figure, and surrounding it with lead, relay it carefully in its place, and fasten round it three nails with a hammer proper for this work, joining to it the chest and arms and the remaining draperies; and whatever part you would solder fasten outside with nails, that it may not be moved from its place. Then have a soldering iron which is long and slender, but at the end thick and round, and at the end of this round part diminishing and small, filed and tinned over; this is placed in the fire. In the mean time take the tin rods which you have cast, and anoint them over on both sides with wax, and rasping lead over the surface in all places which are to be soldered. Taking the hot iron, apply the tin to it in whatever place two pieces of lead meet, and you anoint with the iron until they adhere to each other. The figures being set up, you will arrange the grounds in the same manner, and of whatever colour you wish, and so, piece-meal, you compose your window. The window being finished and soldered on one side, turned upon the other you will make it firm every where in the same manner, by rasping and soldering.

CHAPTER XXVIII.

OF PLACING GEMS UPON PAINTED GLASS.

In figures upon windows, in crosses or books, or in ornament of draperies, if you wish to make gems of another colour upon painted glass, without the lead, such as hyacinths and emeralds, you may act in this manner. When you have designed crosses in their places, upon the head of majesty or on a book, or ornaments upon the border of draperies, which in a picture are made with gold or orpiment, these in windows are made with clear yellow glass. When you have painted which

Quæ cum pinxeris opere fabrili, dispone loca in quibus lapides ponere volueris, acceptisque particulis saphiri clari, forma inde iacinctos secundum quantitatem locorum suorum, et ex viridi vitro smaragdos, et sic age ut inter duos iacinctos semper smaragdus stet. Quibus diligenter in suis locis conjunctis et stabilitis, densum colorem trahe circa eos cum pincello, ita ut inter duo vitra nihil fluat, sicque cum reliquis partibus in furno coque et adhærebunt sibi ita ut nunquam cadant.

CAPUT XXIX.

DE SIMPLICIBUS FENESTRIS.

SI vero volueris simplices fenestras componere, mensuram longitudinis et latitudinis primum fac in lignea tabula, deinde pertrahe nodos vel aliud quod libuerit, distinctisque coloribus componendis, finde vitrum grosâ et conjunge, adhibitisque clavis include plumbo, et solida ex utraque parte, circumpone ligna clavis firmata et confige ubi volueris.

CAPUT XXX.

QUOMODO REFORMETUR VAS VITREUM FRACTUM.

SI fortè vas vitreum cujuscumque generis cadit aut percutitur, ita ut frangatur vel findatur, hoc modo reparetur. Tolle cineres et cribra eos diligenter macerans cum aqua, et inde imple vas fractum et pone ad solem ut siccetur. Cumque omnino cineres sicci fuerint, adjunge vasi partem fractam, cavens ne in junctura cinerum vel aliquæ sordes remaneant,

in the artistic manner, you determine the places in which you wish to lay the stones, and taking small pieces of clear sapphire, form with them hyacinths according to the size of their places, and emeralds from green glass, and act so that an emerald may always stand between two hyacinths. Which being carefully joined together and made firm in their places, paint a thick colour round them with the pencil, so that none may flow between the two glasses, and so, with the other portions, heat them in the furnace; and they will adhere to each other so that they can never fall off.

CHAPTER XXIX.

OF PLAIN WINDOWS.

If, however, you wish to construct plain windows, first mark the measure of the length and breadth upon the wooden table, then draw the flourishes or other things which may please you, and, composing them of decided colours, divide the glass and fit it together with the riesel-iron, and, using the nails, enclose it with lead, and solder on both sides; place wood round it, fastened with nails, and establish it where you wish.

CHAPTER XXX.

HOW A BROKEN GLASS VASE IS REPAIRED.

If by chance a glass vase of any kind should fall or be struck, so that it be broken or cracked, it is mended in this manner. Take ashes and sift them carefully, macerating them with water, and fill the broken glass vessel with them, and place it in the sun that it may be dried. And when the ashes are quite dry, join the broken part to the vase, taking care that no cinders nor any dirt remain in the join: then

et accipe saphirum ac viride vitrum quod a calore flammæ levissime liquefiat, terens diligenter cum aqua super lapidem porfireticum, et cum pincello linies super fracturam subtilem tractum. Deinde pone super tabulam ferream, et eleva vas aliquantulum ex ea parte ubi fractura est, ut flamma super eam æqualiter transeat, sicque mitte in furnum fenestrarum, supponens ligna faginea sicca et ignem paulatim, donec vas calescat et cineres in eo, statimque auge ignem ut flamma crescat. Cumque videris quod vix rubescat, ejectis lignis obstrue diligenter os fornacis et foramen superius, donec penitus refrigeretur. Ablato vase eice cineres absque aqua, sicque lavabis illud et habebis ad quos usus volueris.

CAPUT XXXI.

DE ANULIS.

EX vitro etiam fiunt anuli hoc modo. Compone tibi furnum parvulum ordine quo supra et vascula, deinde acquire tibi cineres, sal, pulverem cupri et plumbum. Hisque compositis distingue colores vitri quos volueris, suppositoque igne et lignis coque. Interim acquire tibi lignum longitudine unius palmi, et grossitudine unius digiti, et in tertia ejus parte pone rotulam ligneam latitudine unius palmæ, ita ut duas partes ligni teneas in manu, et rotula super manum jaceat firmiter ligno conjuncta, et tertia pars ligni super rotulam emineat. Quod lignum in summitate gracile incidatur, et ita in ferro jungatur sicut jungitur in hastâ lancea; quod ferrum habeat longitudinem unius pedis; cui lignum inseratur, ut in junctura æquale sit ligno, et ab ipso loco gracilius sit in finem usque deductum, ubi omnino sit acutum. Et juxta fenestram fornacis in dextra parte, hoc est in sinistra tua, stet lignum grossitudine brachii

take sapphire and green glass, which melts at the heat of a slight flame, grinding carefully with water upon the porphyry stone, and with a pencil paint a thin stroke over the fracture. Then place it upon the iron slab, and raise the glass a little upon that side where the fracture is, that the flame may pass over it equally, and so place it in the oven used for windows, laying under it dry beech-wood and fire, by degrees, until the vase grows hot with the ashes in it, and immediately augment the fire that the flame may increase. And when you see that it has nearly become red, removing the wood, carefully close the mouth of the furnace and the upper opening, until it is altogether cold. The vase being taken out, remove the ashes, without water: and so you will wash it and keep it for whatever service you may wish.

CHAPTER XXXI.

OF RINGS.

Rings are also made from glass in this manner. Arrange for yourself a very small furnace in the above fashion, and some small cups; then procure ashes, salt, powder of copper and lead. These things arranged, choose the colours of the glass which you wish, and fire and wood being placed under, heat them. In the mean time procure for yourself a piece of wood, a palm in length and a finger in breadth, and upon one-third part of it place a wooden wheel the breadth of a palm, so that you may hold two parts of the wood in your hand, and let the wheel remain above your hand firmly fastened to the wood, and let a third part of the wood show itself above the wheel. This wood must be cut thin at the extremity, and be so joined in an iron, as a lance is joined in its pike, and this iron must have the length of a foot, to which the wood is joined, so that at the junction it may be even with the wood, and from this place it may be more slender, diminishing towards the end, where it must be quite pointed. And near the window of the furnace on the right side, that is, on your left, let a piece of wood stand, the thickness of an arm, dug

unius in terra fossum, et pertingens usque ad summitatem fenestræ; in sinistra vero fornacis, hoc est in dextra tua, juxta ipsam fenestram, sit fossula in argilla facta. Deinde cocto vitro, accipe lignum cum rotula et ferro, quod vocatur veru, et pone summitatem ejus in vas vitri, modicumque quod ei adhæserit extrahens punge fortiter in lignum, ut vitrum transforetur, statimque calefac in flamma et percute super lignum bis, ut vitrum dilatetur, atque cum festinatione volve manum tuam cum eodem ferro, ut anulus in rotundum amplificetur; et ita volvendo fac eum descendere usque ad rotulam, ut æqualis fiat. Quo statim ejecto in fossulam, eodem modo operare quantum velis. Quod si volueris anulos tuos aliis coloribus variare, cum acceperis vitrum et transpunxeris cum gracili ferro, eice de alio vase alterius coloris vitrum, in modum fili circumdans eo vitrum anuli, deinde calefactum in flamma, sicut superius, simili modo perfice. Potes etiam super anulum alterius generis vitrum ponere sicut gemmam, et calefac in flamma ut adhæreat.

EXPLICIT LIBER SECUNDUS.

into the ground, and reaching to the top of the window; and on the left of the furnace, that is, on your right, near the same window, let a small trench be made in clay. Then, the glass being cooked, take the wood with the wheel and iron, which is called the spit, and place the end of it in the vase of glass, and taking out the little which may have adhered to it, prick it strongly into the wood, that the glass may be pierced through, and instantly warm it in the flame, and strike it twice upon the wood, that the glass may be dilated, and with quickness revolve your hand with the same iron, that the ring may be enlarged in the circle; and so revolving, make it descend as far as the wheel, that it may become smooth. This being instantly thrown into the trench, make as many as you wish in the same manner. But if you wish to vary your rings with other colours, when you have taken and transpierced the glass with the pointed iron, take from another vase glass of another colour, surrounding the glass of the ring with it in the manner of a thread; then, warmed in the flame as above, finish it in a similar manner. You can also place upon a ring glass of another kind, as a gem, and warm it in the flame that it may adhere.

END OF THE SECOND BOOK.

NOTES TO BOOK II.

"SI VIDERIS," ETC., C. VII., VIII.

Grains of sand (or silica,) and natron (or the carbonates of potash and soda,) having been known from the earliest period, it is probable that the origin of glass would date from the highest antiquity.

The Egyptians had at a remote period heated these alkaline silicates in contact with the metallic oxides, at Thebes and Memphis, and in their temple of "Ptha" or Fire, devoted to the practice of their occult chemical arts [1].

"I have often found in the ruins of ancient cities of the Thebaïd," writes M. Roziere, "amongst the fragments of coloured glass with which they abound, some pieces tinted with various colours. Many of them, affording in some of their parts, beautiful tints of purple, were, I think, remains of the ancient artificial "vasa murrhina"—frits, glasses, enamels, are also found, coloured by metallic oxides [2].

The Phœnicians having traded in the glass of Thebes, became themselves famous in the art of its manufacture. The tale of the fortuitous discovery of glass by them, related by Pliny [3], and frequently quoted, is stated by Merret, upon the authority of the most experienced, to be impossible, as even by the most violent fire glass cannot be made, in any quantity, by burning substances, fit for its composition, in the open air.

[1] Kircher, Œdip. Œgypt. T. 2. Rome, 1653. Alchimia Hieroglyphica.

[2] Rosière, Description de l'Egypte pendant l'Expedition Française. Paris, 1820. T. 6. p. 249.

[3] Plinii Secundi. Hist. Nat. L. 36. C. 26.

The sand of the Belus was probably found purer than elsewhere, and fit for the composition of fine glass, and thus the Phœnicians first became the producers of a beautiful and celebrated white glass, the most difficult of all, at this period, to acquire. For, owing to the presence of metallic oxides in the alkaline carbonate, or the quartzous fragments, the production of a coloured glass would be of earlier date than a pure and colourless vitrification. Theophilus provides for the casual colouring of the "metal" through the mixture of metallic oxides with its elements.

The divers colours of glass not transparent, which Theophilus tells us, c. xii., were found in the edifices of the Pagans, in mosaic work, were doubtless of the kind which were seen in Egypt by M. de Roziere, and the art of making which was transmitted to the Greeks. Pliny[1] remarks upon a manufacture imitating the obsidian stone, "Obsidian stone is also made in stained fashion, for vessels of repast, and a perfectly red glass and not NOT TRANSLUCENT, called hæmatinon. WHITE is also made and MURRHINUM (purple), or HYACINTH and SAPPHIRE, and imitation in ALL OTHER COLOURS." In the previous chapter Pliny mentions that pavements and other ornaments in glass were used by Agrippa in the construction of his baths. This kind of mosaic work, then, served the Byzantine artists in the construction of the enamelled vases which were so beautiful in colour and are now so rare. These enamels are all opaque, and present the appearance of the finest mosaics. Theophilus tells us that white, black, green, yellow, blue, red and purple glass, found also in the form of utensils, were used for this work by the French, who were already "skilful in the art" of working glass. Pliny, indeed, states that Italy, Gaul, and Spain, pursued the manufacture of glass.

This opaque glass was, doubtless, the VITRUM ROMANUM of Eraclius, some of whose chapters are quoted by Theophilus at the end of the third book.

[1] Plinii, Nat. Hist. L. 36. C. 26.

THE LOST CHAPTERS.

Chapters xii., xiii., xiv., xv., of the Harleian Manuscript, are wanting. They have evidently never formed a part of this manuscript, as the chapter which forms our No. xii., " De Diversis Vitri Coloribus non Translucidis," is marked No. xvi. in the index, and yet is a consecutive chapter in the body of the work. They have been abstracted from the original manuscript, now lost, as it is seen elsewhere that the oldest copy of Theophilus known, that in the Imperial Library at Vienna, also wants them, as do the Wolfenbüttel and Nani MSS. Having the titles of these chapters in the index it will perhaps be possible to replace this lacuna with the matter, if not in the words of Theophilus, by consulting the preceding or cotemporaneous Byzantine works, in which this subject is discussed.

C. xii. " Of the colours which are made from Copper, Lead, and Salt."—c. xiii. " Of Green Glass."—c. xiv. " Of Blue Glass."—c. xv. " Of the glass called Gallien." These are the titles of the missing chapters, and they unfortunately leave a great void in the history of the art of the period at which Theophilus wrote. It is not to be doubted that, notwithstanding the resources of the modern artificer in the advances and the aid of science, some of the compositions, of material, of the ancients are in vain sought in our day, although a portion of our glass painters refuse to acknowledge the fact. Where is to be seen in the atelier of to-day the finest and peculiar "blue" traceable until the end of the fifteenth century? Cobalt will not produce this colour; or if so, of what use is our vaunted advance in chemical science, if it yet remains a problem? Should one novelty be produced from the perusal of the following extracts, they will have been found worthy the perusal of the artist, and they will repay the labour of research.

OF GREEN GLASS.

Olympiodorus of Alexandria, who wrote at the commencement of the third century, and a manuscript of whom upon the " sacred art" of alchemy is in the Bibliothèque Royale at Paris, No. 2250, gives us the mode of imitating the emerald.

"Take two ounces of fine crystal and half an ounce of calcined copper, χαλκοῦ κεκαυμένου, grind these substances in a mortar, and melt them together by an equal fire, ἴσῳ πυρί."

In the Byzantine MS. given by Muratori, already referred to, the composition of a green glass is found, p. 370[1].

"DE TINCTIO VITRI PRASINI."

Tere vitrum bene, limas heramen mundum, et mittes in libras de viturum, heramen ÷ III, et coques per dies III.—"Grind glass well, file clean bronze, (or copper,) and put, to a pound of glass, three 'sesunciæ,' (a sesuncia is about 1½ ounce,) and cook for three days."

ALIA TINCTIO.

"Teres vitrum bene. Mitte per . . . . . . heramen, ÷ 1: halumbi Hegiptii, ÷ 1: et quoques per dies III.—"Grind glass well, put to (a pound of glass?) 1 sesuncia of copper, 1 sesuncia of Egyptian alum—and cook for three days.

This "halumbum Ægyptum" should be a native carbonate of soda. See Pl. l. 31, c. 7. It may be borax, for the writings of the Arab alchemists were already exerting their influence. If lead be used in the manufacture of this glass, which is ground and afterwards mixed with the salt and copper, we have here the xiith cap. of Theophilus.

All the ancient green glass was produced from copper alone. Eraclius, the next in rotation upon this theme, affords no further knowledge, as copper and bronze, "auricalchum" are the ingredients, mixed with lead.

[2] "HOW GLASS IS MADE FROM LEAD, AND HOW IT IS COLOURED."

"Take the best and bright lead and put it into a new pot and burn it on the fire until it become a powder. Then take it from

[1] Muratori, Antiquitates Ital. Medii Ævi. Vol. ii. p. 370.

[2] Taken from the Eraclius in the Paris Manuscript, No. 6741; it somewhat differs from the chapter given by Raspe from the MS. of Trinity Col. Cambridge, now in the British Museum.

the fire that it may cool. Afterwards take sand and mix it with this powder, so however that two parts may be lead and the third sand, place it in an earthen vessel and act as is written above for making glass, and place this vessel in the furnace and continually stir it until the glass is made. If, however, you wish to act so as to make a green glass, take filings of bronze (auricalcum) and put them in together with the lead glass, as much as appears right; then if you wish to make any vessel, do so with the iron tube. Afterwards take out the vessel with the glass, and allow it to become cold."

Two chapters found at the end of this Harleian MS. in a book, "De Unguentis," and which is a compilation of medical recipes, treat of green glass; orpiment is the colouring metal of one. In p. 142 of the MS.

"SHOULD YOU WISH TO MAKE A CHRYSOLITE OF GLASS."

"Take crystal and place it in alum (Qu.? potash or soda) for eleven days, then cook it with orpiment and it will be a chrysolite."

"SHOULD YOU WISH TO MAKE AN EMERALD FROM GLASS."

"Place crystal in alum for twelve days, then cook it with green copper, and it will be an emerald." These have not been written later than the commencement of the thirteenth century.

OF SAPPHIRE GLASS.

Theophilus, in c. xii. tells us that the Greek mosaic sapphire stones were melted with white glass in order to form costly plates of sapphire, for windows; and in c. xiii. that the Greeks made drinking cups from the same stones, which they ornamented with gold. Having already remarked upon what may be regarded as the sapphire of the Greeks, in a note to the first book (p. 77, et seq.), I do no more than call the attention of the reader to the opinion there expressed that the Σάπφειρος of the ancient Greeks was our lapis lazuli. The sapphire of Theophrastus which is

spotted with gold[1], and which is of a dark dye, and not very different from the male Cyanus[2], is no other than that stone.

That the Sapphire (or lapis lazuli) was employed in order to colour glass of a rich blue, I hope to be enabled to show, and that this was the substance which produced the fine and peculiar tints both in glass and enamel, there will be no reason in many instances to doubt; may the artist succeed in reproducing these, and in recovering a lost branch of his art.

The Byzantine MS. given by Muratori is silent upon the subject of a blue glass.

Eraclius informs us, after having directed the manufacture of a glass of silica fluxed with lead, "De isto vitro plumbeo, ille scilicet qui cœruleus est, qui de duobus coloribus potest fieri, poteris si vis cum pulvere saphireo miscere ad pingendum in vitro."—"From this lead glass, that one namely which is blue, which can be made of two colours, you can mix, if you wish, SAPPHIRE powder for painting upon glass."[3] Again,

"QUOMODO PINGITUR IN VITRO."

"Dicendum quo modo pingere debes in vitro. Accipe grossinum de saphiro et palliam quæ excutitur de calido ferro super incudem fabri, cum grossino tertiam partem pones, et plumbeum vitrum, judicatim scilicet, misces, et super marmorem ferreum fortiter teres, sicque pingere potest."

"HOW A PAINTING IS MADE UPON GLASS."

"It must be told how you should paint in glass. Take a piece of SAPPHIRE, and the rust which is struck from the hot iron upon the smith's anvil, you put a third part with the piece (of sapphire), and you mix lead glass, with judgment, and you grind it strongly upon an iron slab, and it can thus be painted with."

Eraclius mentions "Lazur" in a composition for colouring earthenware vases of a dark hue; this is noticed elsewhere as probably a preparation from copper or cobalt.

[1] Theophrastus, περὶ τῶν λίθων. XLIII. Translated by Hill.

[2] Idem. LXV.

[3] These extracts are taken from the Eraclius in the Le Begue MS., Paris, which somewhat differs from the Trinity College MS., although, in substance, similar.

Suger, who was employed by Louis le Gros to direct the works at St. Denis in the embellishment of the Abbey, tells us that "the workmen pounded 'sapphires' in abundance, and burnt them in (or upon) the glass, to give it the colour of azure."[1]

In the Sloane collection of MSS. in the British Museum, No. 1754, of the early part of the fourteenth century, is a short treatise on colouring crystal. After directing that the crystal be several times heated and well washed, it proceeds—

"Vous prendrez un pot de terre plumbe de dens, et pus si pernez une livre de vostre poudre de cristas et de mye lyvre de vostre sel niter et de sans de verre, vi medlez ove vostre poudre de cristal, vous le criblez bien ensemble vi les metez en vostre pot vi covrierez cel pot de un covercel ke seyt en milu perce. Vi devez avez un tuel de fer ke pus entrez en cel perce, par ou la fumosite puse isser, et ce pot deyt byen estre arsilez tot en viroun." This is placed in the fire for a day and night. It then continues:

"Who wishes to make a precious green, clear and bright stone from the crystal here composed, must take calcined lead (prenge cendres de plumb ars mult menu criblez), and grind it very fine. I will tell you how you must make this calcined lead. Melt the lead in a round pot, take powder of orpiment finely pulverized, you throw it upon the lead when it is melted, stir it well until the lead is burnt to powder and becomes a cinder, then take this cinder and grind it in a mortar." (This is a litharge, the protoxide of lead.)

100 drachms of this "cristal" and two drachms and a half of this "calcined lead" are then ground, sifted and washed, and dried in the sun. "Then you take 100 drachms of this cristal and two and a half of the finely sifted lead, place these in an earthen pot which can sustain a great fire, you cook a day and a whole night, then extinguish the fire and you will find a beautiful and bright stone, and green as an emerald."

"If you wish to make SAPPHIRE (Safir) from this 'cristal,' take of the cristal 100 drachms, and of the calcined lead five drachms, you cook them (vi les quisez) a whole night and day; when melted you break it up in a mortar and sift (saciez) it small and take five

[1] Histoire de St. Denys, par Doublet. Paris, 1625, p. 242.

drachms of good azure, fine, which can sustain fire without losing its colour; grind it fine with the cristal powder, put it in a pot and allow it to cook three days and three nights, then extinguish the fire and allow it to cool, and you will find the glass melted and well coloured like a sapphire."

Paul de Canotanto[1] places this beyond a doubt, for he mentions "lapis lazuli" as the substance to be employed for tinging glass of a sapphire colour.

Paul de Canotanto appears to have lived early in the fifteenth century; the writing is of this epoch, and he tells us he was a native of Tarento. His book is entitled "Theoria ultra estimationem peroptima ad cognitionem totius alkimiæ veritatis." In the second or practical part is a notice upon the fabrication of gems.

"Si Smaragdum habere volueris, apponas viride æs; si vero Sapphir ponas satis de lapide lazuli: si Jacinthum violaceum, ponas vel minus vel plus lapidis dicti: si Jacinthum Granatum, ponas de pulvere Malachitis; si Chrysolithum, pone Arsenicum: si Topasium, mediocriter ponas arsenicum."

"Should you wish to have an Emerald, use green copper (the bi-acetate): if a Sapphire add enough 'LAPIS LAZULI'; if a violet coloured Hyacinth, put less or more of the same stone: if a Garnet hyacinth, put powder of malachite: if a Chrysolite, use arsenic: if a Topaz, use arsenic moderately.

Alexius[2], Mizaldus, Babtista Porta, Neri, De Piles, and other authorities mention the lapis lazuli as an ingredient in the composition of glass of different shades of blue.

C. XV. "OF THE GLASS CALLED GALLIEN."

Theophilus having taught the processes for making varieties of green and a blue glass, would proceed to describe the manufacture of a red. The origin of the term "Gallien," as applied to a red glass, is open to conjecture, whether from the Greek, "καλὸς," beauty; or from "Galienus," under whose reign the arts were cultivated, and in whose time arabesque and other architectural

[1] No. 7159. Bibliothèque Royale, Paris.

[2] Alexius de Secretis, 4° Lucca, 1557, is the best edition of this author.

ornaments were introduced into Rome[1]; probably from the latter cause.

Eraclius, "De Artibus Romanorum," is the only author, with the exception of Theophilus, who makes mention of "vitrum gallienum;" and, fortunately, his chapter upon this subject is not lost to us[2]. After describing the manufacture of white glass, Eraclius proceeds to direct the colouring of it.

"Si vero vis ut efficiatur rubeum de cinere tamen[3] bene cocto sic facies."

"But should you wish to make a red from the 'ashes,' well cooked, however, you act thus. Take the filing of copper, and burn it until it becomes powder, and place it into the small vessels of glass, and it will become a red glass, which we call Gallien:" "quem Gallienum vocamus."

The "Gallien," then, was the deep carmine-coloured glass procured from a protoxide of copper, which is now generally flashed upon a white glass, as, unless worked as soon as the red colour appears, it becomes of a tint too intense, to be serviceable.

The MS. Sloane, 1754, already quoted, fol. 153, contains a recipe for a red glass.

"If you wish to make beautiful, clear, and shining red stones, take 100 drachms of your cristal," and two and a half drachms of black oxide of iron, (magnesia ferrea,) this is the magnetic stone which attracts iron; (ce est une pyere ke est aymant si tret fer;) place it to cook for five days and five nights in the pot, then withdraw the fire and allow it to cool."

Pliny also mentions this protoxide of iron for the purpose of staining glass. "Cæptus addi et magnes lapis; quoniam in se liquorem vitri quoque, ut ferrum, trahere creditur."[4]

[1] Emeric David. Discours Hist. sur la Peinture, p. 17.

[2] Raspe. "Eraclius de Artibus Romanorum," p. 112; et "Liber Tertii Eraclii." MS. Bibliothèque Royale, Paris, No. 6741.

[3] I quote from the Cambridge MS. itself, (Raspe reads it, "non bene cocto,") as the "cinis" of Eraclius is the heated mixture of sand and potash.

[4] Plinii. Nat. Hist. L. 36, C. 26.

C. XIII. AND C. XIV. "VITRUM CLARISSIMUM, VELUT CRYSTALLUM, QUOD IPSI COMPONUNT."

The "very clear glass like crystal" used by the Greeks, in order to attach gold leaf to vases, and which in C. xiv. is employed upon an ornament of gold, or silver, previously laid upon glass, is no other than a flux capable of retaining and combining, by the action of fire, with the various vitreous colouring substances afterwards superposed. This last chapter indeed proves that the Byzantine Greeks practised the art of PAINTING UPON GLASS, an art which all the French writers, from Le Viel to M. E. Thibaud, with perhaps a laudable partiality, labour to prove of French origin, and of the twelfth or thirteenth century.

Emeric David[1] indeed, in exception, mentions that the historian of the monastery of St. Begnine, who wrote about 1052, declares that there existed, *yet in his time*, in the church of the monastery, a very ancient glass window, representing the martyrdom of St. Paschasie, and that this painting had been taken from the old church, restored by Charles the Bald, (A. D. 850,) "UT QUÆDAM VITREA ANTIQUITÙS FACTA, et usque ad nostra perdurans tempora, eleganti præmonstrabat picturâ."

The Benedictines have ascribed this invention to the period of Charlemagne, T. 6, p. 66, and with more reason. For Theophilus not only describes the ornamenting of cups, vases, and other utensils, by means of coloured glass fluxed upon a white ground; but in C. 21 are found clear directions for painting upon glass. "In the same manner you make grounds of the clearest white, the figures of which grounds you ornament with sapphire, green, purple, and red." The dark colour is to take the place of posc in marking the nude, &c.

Traces of a flux for the purpose of ornamenting vases, whether of glass or earthenware, are found scattered through the books of Eraclius. The art of rendering glass more fusible by means of litharge was well known to that writer.

A very curious Manuscript in the Sloane collection, No. 3661, which encloses the practice of an anonymous alchemist of the four-

[1] Emeric David, loc. cit., p. 151.

teenth century, with a variety of other matters, contains also a treatise upon colouring glass. The MS. is written in the sixteenth century, and is a copy from an older work. It contains the following notice:—"This booke pertayneth to me John Elyot, which was written out of an old copye (by William Belyngslie, oon of the costmers of the port of Bristowe) in anno 1572: which copye seemeth to be above 200 yers old."

As this MS. contains the practice of ornamenting glass during a period of which we have few, if any, records of the art, I have collected some fragments which may be acceptable to the reader.

A BLUE COLOUR.

P. 4. "Color Blavum." Blavus color is said to be of a purple, or blue, in the Catholicon and the Tabula de Voc. Synon. of Le Begue; it is a Byzantine term.

Purified crystal glass, 10 ℔: ground and pulverized Zaffer, 1 drachm. (Cobalt, sometimes, which took that name during these periods from resemblance to the colour of the Greek sapphire, when combined with a silicate.) These materials are to be ground and placed in the furnace.

"A VIOLET COLOUR." "COLOR VIOLETUS."

Purified crystal glass, 10 ℔.
Project into it 1 ℔ of manganese, ground. "Magnesia."
Grind and place it in the furnace.

"AN EMERALD COLOUR." "COLOR SMARALDI."

Prepared crystal glass, 1 ℔.
Calcined lead, 1 ℔.
Scales of copper, prepared, 2 ℔. (Qu.? 2 oz.)
Green glass, 1 ℔.
Scales of iron, 1 oz.
Grind all together and place it in the furnace.

"A PALE RUBY COLOUR." "COLOR BALASSII."

Prepared crystal glass, 10 ℔.
Scales of copper, 1 part by weight to 20 parts by weight of crystal.
1 oz. yellow oxide of iron. (croci ferri.)
Grind, and place it in the furnace.

"A RUBY COLOUR." "COLOR RUBINI."

Take the tartar of red wine, thick, and hard to break, 3 parts.
Prepared crystal glass, 2 parts.
Grind and melt this.
Then take 20 parts by weight of this, and 1 part by weight of scale of copper.
Yellow oxide of iron, ½ an oz. (croci ferri.)
Grind this together with red wine, place it in the furnace, withdraw and powder it; replace it four times.

This bi-tartrate of potash, which was used as extensively as the borate of soda is now, in the composition of a flux for glass, and in the preparation of pigments, here serves to deoxidize the "scale," or red oxide of copper[1], and the red colour is evolved. Other substances containing carbon are serviceable for this purpose.

"THE MODE OF PREPARING SOME INGREDIENTS BELONGING TO THE ABOVE WORK."

"The scale of copper is thus prepared. Take as much copper scale as you wish, and grind it well, and dissolve it in vinegar, (in aceto,) and pass it through a filter, (distilla per filtrum[2],) and you can do this again, as above, and that which is strained you inspissate, and grind it well to your fancy. And you can do thus with scales of iron; and yellow of iron is treated in a similar manner."

"Zaffer (Zaffira) is thus purified:—Take 2 oz. of it and grind it well upon porphyry, with acidulous water, after the fashion of the above colours, for four hours, and lay it out to dry; add water when it is wanted in grinding."

[1] The "æs ustum" of the ancients.

[2] Numerous errors appear to have arisen from not distinguishing the phrase "distillare per filtrum" from "distillare," by which latter was intended "distillare per alembicum," or to distil.

"The calcination of tartar of red and white wine is thus made. Wash hard tartar often in water, and place it to be calcined in a reverberatory furnace, with little fire at first; augment it afterwards until it grows white inside. Then cast it into hot water in a clean vessel, and dissolve it with a clean spatula, and when it has become dissolved, allow it to cool. Afterwards pass it through a filter, then bear it upon the fire and inspissate that which is strained, and afterwards grind it and put it into an uncovered pot to calcine, until the pot is red hot, for one hour, perhaps; afterwards extract and grind and dissolve it in hot water and expose it to cool; afterwards filter and evaporate, again calcine it as before another hour; dissolve, evaporate, and calcine it: when it runs upon a plate or the furnace without fume it is then proper for melting crystal."

"THE METHOD OF MELTING GLASS IS QUICK AND EASY."

"Take clear crystal, as much as you please, and in large stones, so that it may be the size of a hen's egg, or half, and place these pieces in a brass or iron vessel, extra-luted, in a coal fire, and when they shall become glowing, quench these stones of crystal in good oil of tartar, (in oleo bono tartari[1],) white and pure, and do the like seven, or more, times; afterwards grind it very fine in a mortar, and pulverize it well and sift it; afterwards put the powder into an iron pot, (caryfia,) and place it upon a coal fire; it is then quickly and easily melted. Know that when the crystal is soft over the fire, you should throw oil of tartar into it drop by drop, and it will be easily melted; and when it has become fused cast it upon plates of iron."

"ANOTHER FLUX OF CRYSTAL GLASS." "ALIA FUSIO CHRYSTALLI."

"Take crystal very finely powdered and calcined, 1 part: sal alkali, 2 parts: mix them in a proper vessel, and place it in the glass furnace, and when fused add the colours mentioned below."

"ANOTHER FLUX FOR CRYSTAL."

"Take crystal, and well purified oil of tartar, project the latter

[1] Is this the tartrate of potash? or the carbonate of potash in a deliquescent state? Probably the former.

drop by drop upon the former upon the fire until it commences to be fused; this being done and pulverized upon the marble, add nitre (sal āonī, = *afronitri, or nitrate of potash,*) and place it in a glazed vessel to dissolve."

"ANOTHER FLUX."

"Take the glass you wish, and place it in a crucible, or an iron vase, upon a strong fire, until it is made quite red, and afterwards throw it into cold water, then withdraw and dry it, and grind it well, and sift it very fine, and grind it upon a marble until it is made impalpable. Then place the powder in an earthen crucible (+bo.), and put the said glass powder and sal alkali (*carb. of potash*), equal parts, or even Alexandrian Nitre, (dī sale nitro Alexandrino, *Borax*[1],) powdered and mixed together in the crucible, and place the crucible in a flaming furnace, and it is melted, and the salt will be evaporated and the crystal will remain fused, which you can colour as you please."

The same manuscript contains the method of making false gems, the recipes for the colours for which will be, perhaps, worth perusal. The whole book upon glass manufacture is of interest, as it appears to contain the processes of this branch of art employed in our own country at a period when we were inferior to none in the science of glass decoration, only equalled by the French, whose monuments have but partially suffered during the momentous convulsions which at the close of the last century agitated their country, while we have to deplore an extreme loss effected through the virulence of iconoclastic barbarity.

It is worthy of remark that these signs which follow, in some places, are all of the Byzantine Greek period, and frequently met with in the manuscripts of this school concerning "the sacred art," alchemy.

FOL. 61. "IF YOU WISH TO MAKE THE CARBUNCLE.

"Take, ♁ (*gold,*) finely calcined, which you have separated from all salt, 1 part: sal alkali, 2 parts: and melt in the glass furnace."

[1] La Borace dagli antichi si chiama "Chrisocolla," e gli Arabi scrittori "Nitro Alessandrino."—Alexius de Secretis. Lucca, 1557, p. 179.

"IF YOU WISH TO MAKE RUBY.

"Take 1 part yellow oxide of iron, and 2 parts salis alkali," (*carb. of potash*).

"IF YOU WISH TO MAKE SAPPHIRE.

"Take 1 part atzurii ar^{m}. (This must either mean the lapis armenus, or the lapis lazuli, the 'sapphiros' of the Greeks; they were confounded one with the other during the middle ages: the latter stone is certainly intended[1],) and 2 parts salis alkali."

"IF YOU WISH HYACINTH.

"Take 1 part salis alkali, half a part protoxide of gold, (calcis $\odot^{is}$. =) and half a part ground iron."

"IF YOU WISH EMERALD.

"Take 2 parts salis alkali, and a little oxide of copper (calcis cupri), well prepared."

"IF YOU WISH A TOPAZ.

"Take 2 parts sal alkali, a little oxide of gold, and a little calcis ♄^{ni}. (protoxide, or per-oxide of lead.)

"IF YOU WISH A GARNET.

"Take 2 parts sal alkali, and a little oxide of gold, and a little hæmatite." (Lapidis sanguinariæ.)

"IF YOU WISH A CHRYSOLITE."

"Take 2 parts salis alkali and one part of prepared calamine of zinc." (Tutiæ calaminaris preparatæ.)

[1] Léviel, however, who informs us that he writes from "old family recipes," tells us that "bleu de montagne," and "grains de rocaille," are used to manufacture a blue glass. The "bleu de montagne," as the Armenian stone, is coloured by carbonate of copper. This mixture alone would not produce a blue glass.

"IF YOU WISH A TURQUOISE.

"Take 2 parts salis alkali and half a part oxide of gold (calcis ☉is.), and half a part azurii de arm. (sapphire.)"

"IF CARNELIAN.

"Take 2 parts salis alkali and half a part oxide of tin, calcis ☿ii, (this mark, or one analogous, was sometimes used for mercury,) and half a part of golden marcasite, and half a part oak ashes. (cineris balanytiæ, ἀ βαλανιδιά." *Qu.*?)

P. 6. "FOR MAKING SAPPHIRE." "Zaphiros."

Take crystal 1 lib. grind it very fine and sift it, afterwards put ½ ℔ of the powder of stag's bones burnt, if you can procure them, if not of other animals, or sal alkali lib. ½, grind all very fine, and mix them well together; take this powder and put it into a strong pot, and covered and luted outside; when you have cooked this in the glass-maker's furnace, allow it to remain five or seven days, which is better, and it is there melted like glass. Afterwards place good *ultramarine blue*[1] ("azurio ultramarino") and being mixed together it will make the celestial colour for making sapphires."

This would, owing to the presence of phosphate of lime, produce an opaque glass.

In a manuscript of the fourteenth century in the Bibliothèque Royale at Paris is the following practice of making a flux for glass. MS. 7147. Fol. 69.

"TO MELT GLASS AND SIMILAR THINGS."

"Take 'salis petræ,' (probably bitartrate of potash, rather than the nitrate,) "borrax," "ceruse," equal quantities; mix them well together, pulverized with oil of eggs: thus, as a paste

[1] Beckmann writes that the first mention of the word *ultramarine*, as made from the lapis lazuli, is found in Camillus Leonardus, 1502. It is to be found in the book of John of Modena, "pictoris habitantis in Bononia." From which the mode of preparation was copied in 1410, for John Le Begue. This method is similar to that now employed. The term appears to have been used in Roman art.

and dry, this powder will cause crystal and other things to melt."

The oil of eggs was supposed to possess great virtues in the middle ages.

C. XVI. "DE VASIS, ETC., PICTIS."

For painting earthenware vessels the Greeks were accustomed to use coloured fluxes mixed with different pigments suitable to the purpose. This art would naturally lead to that of painting upon glass, the transition would likewise be immediate. In chap. xv. Theophilus informs us that the same people made "glass tablets, as in window work," which they ornamented with gold, laying a flux behind the leaf in order to protect it. This was principally used in mosaic work: the decoration of vases with gold leaf and coloured ornamental work, having been applied to glass, as well as fictile vases and cups, became transferred to the glass plates, and thus were introduced into window-work.

Eraclius, who is quoted by Theophilus in the third book, gives a chapter upon this subject.

It would not, perhaps, be uninteresting to the artist were I to give an extract from a manuscript of Sir T. De Mayerne, upon the Arts, which I am preparing for publication with the consent of the Trustees of the British Museum. Sir T. D. Mayerne was the physician successively of Henry IV. and Louis XIII. of France, of James I. and Charles I. of England; he was a great lover of art, and being one of the most scientific men of his age, had access to the ateliers of all the principal artists of the period in Italy, Flanders, France, and England.

An extract taken from the book of "Mr. Colladon."

"Couleurs des Esmaulx ou vernix de la Poterie de Faience. Copie de l'original d'un Maistre potier Anglais."

The English artificer was, as well as the artist, eminent at this period; these colours were used either upon porcelain or glass, as will be seen below. The recipes appear to be of Italian origin.

"TRANSPARENT WHITE.

"Borax, 10 parts. Lead, 8. Flint, 7. Cristall 10. Sand 7."

"BLUE.

"Cristall, 18. Azur, 4. Zafer, 1. Lead, 4.

"VIOLET.

"Borax, 18. Zafer, 6. Flint, 8."

"BLACK.

"Borax, 20. Zafer, 4. Manganese, 3. Sand, 2. Crystal, 2. Lead, 10."

"YELLOW.

"Lead, 15. Antimony, 1½. Cristall, 2. Sand, 2."

"GOLD.

"Lead, 15. Minerall, 5. Flint, 5. Cristall, 5. Iron rust, 1¼."

"GREENE.

"Crystall, 5. Sand, 5. Lead, 15. Verditer, 5. Flint, 5. Pin-dust, 1½."

"ANOTHER GREENE.

"Buros, 18. Lead, 4. Bisgreen, 12. Flint, 8."

"OTHER GREENE.

"Cristall, 5. Lead, 15. Pindust, 1. Flint, 5. Sand, 5."

"SKIE COLOR.

"Buros, 18. Lead, 18. Zafer, 4."

"TANY.

"Sand, 5. Cristall, 5. Lead, 15. Manganese, 1½. Flint, 5."

"ANOTHER BLUE.

"Cristall, 18. Lead, 6. Buros, 18. Zafer, 4½. Azure, 4."

"OTHER BLUE.

"Lead, 6. Cristall, 18. Azure, 10. Buros, 4. Manganese, ¼, or ½."

"ASH COLOUR.

"Borax, 18. Lead, 8. Zaffer, 4. Manganese, 1, or ½, or ¼."

"PALE GREY.

"Buros, 18. Lead, 8. Azure, 4."

"GREY HAIR.

"Lead, 15. Azure, 6. Flint, 3. Zafer, 3. Cristall, 3. Manganese, ½."

"CARNATION.

"Buros, 20. Lead, 8. Flint, 12. Manganese, ½."

"WATER COLOUR.

"Buros, 18. Lead, 6. Zafir, 6. Flint, 6."

"PALE GREY.

"Blue, 1. Tany 1."

"GALI COLOUR, RED." (*From Gallien? !*)

"Lead, 2. Rust, 2. Antimony, 1, or ½. Tartar, 1, or ½."

"GREENE.

"Sand, 2. Pin-dust, 3. Lead, 2. Antimony, 1."

"YELLOW.

"Lead, 2 lb. Antimony, 1½ lb. Argall, 1½ lb. Rust, 2 oz. Calemenare, 2 oz.

"BLANC D'ITALIE.

"Sable blanc, v. lb. Sande, 1 lb. (*Sandiver.*) calcine: Lead, iii. lb. Tin, 1 lb., calcine to whiteness."

"Bouras" is that of the goldsmiths. (*The Chrysocolla of the middle age, or Borax.*)

"Lead," is lead calcined without addition.

"Cristall," is very clear glass of Venice.

"Azur," that which is used in starch.

Flints are calcined to whiteness. Manganese is a stone which comes from Spain. Antimony is used without preparation. Iron

rust is that found upon the old anchors of ships. Bis-greene is the spume of glass. Gali colour is a dark red. Argal is white tartar. Calaminares is not the lapis calaminaris, but a white matter very pungent in the taste. (*This is the spodium of the ancients; the oxide of Zinc.*)

Gali colour red; Water-colour, Green and Yellow are only applied upon the Blanc d'Italie.

" A RED FOR GLASS OR PORCELAINE, UPON WHITE.

" Iron rust, 2 lb. Lead, 8 lb. Calcine three times, grinding them to a powder each time."

" ANOTHER RED.

" Antimony, 8 lb. Litharge, 8 lb. Iron rust, 8 lb. Calcine three times."

" GREEN.

" Antimony, 8 lb. Calcined lead, 9 lb. Copper filings, 9 lb. Calcine three times."

" BLANC D'ITALIE.

" White sand, 5 lb. Soda, 1 lb. Calcine in form of a light pumice stone. This is called 'Fread' (Frit?). Then take 3 lb. lead and 1 lb. tin; calcine these two substances to whiteness.

" You will make the above white by taking 20 lb. of 'Fread' and 12 lb. of calcined lead and tin. Calcine and grind very fine upon Porphyry."

Ashes, salt, powder of copper and lead are all that Theophilus directs in the composition of a soft glass for rings. These are mixed with a coloured glass. C. 31.

C. XIX. "TERES CUM VINO," ETC.

"The mode of introducing a salt into the colour with which 'glass is painted' is perhaps worth remark. The pigments were ground with wine or urine, an addition of salt to the flux was thus obtained, in the shape of either the alkaline phosphates, or the tartrate of potash."

C. XXI. "CROCEO VITRO NON MULTUM UTERIS."

The recommendation of Theophilus to avoid the introduction of yellow glass in windows, unless in ornaments, or where gold is placed in paintings, is worthy of remark; the unpleasant and hot appearance of many of our modern specimens attest the value of the recommendation. The French artists have noticed this effect; they also observe that such a custom if abused "fait trou" in the composition.

C. XXVIII. "CRUCES IN CAPITE MAJESTATIS."

At an epoch when the painters and other artists, employed in the decoration of sacred edifices, were either belonging to, or under the influence of the church, the laws of religious iconography were faithfully observed; the nimbus or glory, by which the heads of Divine, or sainted, personages were surrounded, was emblematical of the sacred character. M. Didron, in the "Iconographie Chrétienne," informs us that when a figure is without the nimbus, it may certainly be said that it is no representation of a saint.

A more sacred character still was given to the Divinity, the Angels and Apostles; these were alone represented with the feet uncovered. Neither the Virgin nor other saints were thus represented at this epoch.

Every figure with the nimbus is a saint, every saint with nude feet is at the least an apostle; every figure with a nimbus orna-

mented with a cross can be but one of the three Divine personages: this, adds M. Didron, is the invariable rule.

Until the eleventh century the Latin church, as well as the Greek, fraternized with the Jewish religion. An enamelled cross of the Abbey of Saint Bertin, a romaic cross of the eleventh century, gives the nimbus, the character of saint, to Moses, to his brother Aaron, to the prophet who marks the elect with the "thau," to Isaac, to Joshua and Caleb. But at the moment of the consummation of the schism, this respect, which the Latin church formerly entertained for the personages of the Old Testament, sensibly diminished; the Byzantine influence, alone, partially preserved it, but in the fourteenth century the Christian saints only kept this attribute. The Greeks continue the practice unto this day [1].

C. XXX. QUOMODO REFORMETUR VAS VITREUM FRACTUM.

This invention appears to have been made in the reign of Tiberius Cæsar, and to have led to the fable of malleable glass. Pliny, who has been quoted by St. Isidore, mentions an invention of a composition, or tempering, which rendered glass tender, and that Tiberius, fearing this would depreciate the value of the precious metals, abolished the workshop of the artificer. This story has been wonderfully improved by St. Isidore, who adds a hammer to the tale, and converts the "tender" or "tractable glass" mentioned by Pliny into one which is "malleable." Eraclius quotes from St. Isidore, rather than from Pliny, whose version is too plain to admit of the marvellous.

Pliny writes, "Ferunt, Tiberio principe, excogitatum vitri temperamentum, ut flexibile esset: et totam officinam artificis ejus abolitam, ne æris, argenti, auri, metallis pretia detraherentur: eáque fama crebrior diu, quam certior fuit." [2]

St. Isidore, disregarding the doubt expressed by Pliny, that glass could even be rendered more tractable, writes [3]—"It is related that, under Tiberius Cæsar, an artificer invented a tempering for glass, which rendered it tender *and ductile* (*flexibile et ductile*),

[1] Manuel d'Iconographie Chrétienne, p. 134.

[2] Pliny. L. 36. C. 26.

[3] Opera S. Isidori. L. 16. C. 16. Raspe, Lib. Eraclii. 3. p. 111.

When admitted to Cæsar he held out the jar to him, who, angry, threw it upon the pavement, where it bent like a brass vase. The artificer raised the jar from the floor, thrust a small hammer into the cavity, and mended the jar. This done, Cæsar asked the artificer whether any other person knew this tempering for glass, and when he denied, with an oath, that any other knew of it, Cæsar ordered him to be decapitated; lest, this known, gold and silver might become as clay, and the value of all metals be debased. For, in truth, did glass vessels not break they would be better than gold or silver."

We see that the relation of Pliny has been much *improved*, and that Isidore has perpetrated, or perpetuated, an error which gave much trouble to many an alchemist of the middle ages.

Pliny, L. 29, c. 3, gives us the process usually followed in his time for cementing broken glass, "candidum ex his (ovis) admistum calci vivæ glutinat vitri fragmenta;" "white of an egg, mixed with quick-lime, glues together the fragments of glass."

DE COMPONENDIS FENESTRIS.

Of the use of coloured glass by the ancients it has been shown that we have proof. The enamelled charms, (*abracadabra*,) and the "abaculi" of the Greeks and Romans, yet in existence, show this. The Romans employed glass in the embellishment of their apartments, and Seneca appears to intend that mirrors were employed for this purpose, as at the present day. "Pauper sibi videtur ac sordidus, nisi parietes magnis et pretiosis orbibus refulserunt, nisi vitro absconditur camera." Epist. 86 [1].

[1] See Diodorus Siculus. Vol. 1, p. 163. II. Wesseling. Who tells us that in a country near Egypt variously coloured crystal is made by "divine fire." (ὑπὸ θείου πυρός.)

Dutens states that during the excavations at Pompeii in 1778, the windows of some chambers, attached to the baths, were found glazed with as fine glass as that of the moderns. Lactantius [1] and St. Jerome [2], writers of the third and fourth centuries, both speak of glazed windows. The employment of coloured glass arranged in Mosaic fashion, the "fenestra simplex," c. 29 of Theophilus, would soon give place to the use of painted glass as the art advanced. Observant of the effects of colour productive of such admiration during the early efforts of art, new exertions, in order to unite the beauty of pictorial effect with the previous richness of decoration, would doubtless soon be made to call to aid the talents of the Christian artist.

In the sixth century, when Fortunatus of Poitiers [3] lauds the bishops who ornamented their churches with large windows of glass, and the effect which they produced by the rays of the sun; he, by this, evidently intends a coloured glass.

Sidonius Apollinaris [4], in his letter to Hesperius, speaks positively of coloured glass having been used in the windows of the church erected by Patiens, at Lyons.

"Ecclesia nuper constructa est Lugduni, quæ studio papæ Patientis ad summum cœpti operis accessit, viri sancti, strenui, &c.

> "Intus lux micat, atque bracteatum
> Sol sic sollicitatur ad lacunar,
> Fulvo ut concolor erret in metallo,
> Distinctum vario nitore marmor
> Percurrit cameram, solum, fenestras.
> Ac sub versicoloribus figuris
> Vernans herbida crusta saphiratos
> Flectit per prasinum vitrum lapillos."

Fortunatus and Paul the hermit, as well as Theophilus, describe the admirable effect which the rising sun produced through the windows of St. Sophia at Constantinople. (See Preface to this Book, p. 117.)

It is more than probable that all these early ornamental windows were in the Mosaic style of art, and that the various glass was coloured by the combination of the metallic oxides with the glass

[1] De opificio Dei.
[2] St. Jerome. Glossary. "Vitræ."
[3] "Carmin." L. 2.
[4] "Epist." 10. L. 2.

itself in the pot, and that the invention we are called upon to notice, as next in rotation, is the method of colouring white glass by means of a flux, "vitri lucidissimi." In c. 12 and 13, Theophilus does not neglect the mention of this process, whereby he tells us that "the FRENCH made costly plates of sapphire, purple and green, very useful in windows," and in c. 13, he informs us that the "vitrum clarissimum," used as a flux, was composed by the GREEKS. Theophilus, who asserts that he has "embraced the nature of glass," subsequent to his visit to St. Sophia, and his admiration of the effect produced by the different hues thrown upon the chancel, is the first practical author who enters minutely into a description of the processes of the glass painter, and, as a practical artist, is the more worthy of our serious attention. The art of enamelling glass was then known to the Byzantine Greeks; the statement of the historian of the monastery of St. Begnine is, therefore, most credible, although attacked by the later French writers in order to support their pretensions, and the opinion of the Benedictines, that pictorial representation upon glass dates from the period of Charlemagne, is supported. The art of producing a picture by means of gradation of shadow, thereby forming combinations of light, shade, and colour with the plate of stained or enamelled glass subjected to this process, was the first and great step taken in the art of glass painting. It is the process of Theophilus, who, however, appears to have entertained the idea of painting objects upon glass with coloured fluxes, in imitation of the ornaments upon vases and cups.

That this process was more congenial to the production of excellence in window work than any other, the remains of church windows, executed from the beginning of the eleventh to the end of the fifteenth century, are in evidence to attest.

Reasons for this are not wanting; they have lately been brought forward with great happiness by the later writers upon the art, and who attempt to prove that in order to return to the excellence shown at the periods above referred to, the same simplicity of shadows and breadth and purity of colour must be returned to.

The care of the painters of these later periods in the taste and purity of outline is another cause of the excellence of their works. Outline and arrangement of colour were the points to which all other considerations properly yielded, in this mode of decoration, viewed by the means of transmitted light alone; which trans-

mission, while it was found to blend and harmonize the rays of coloured light before they reached the observer, rendered nugatory, or poor, the greys[1] introduced by yet later artists in order to blend their colour with shadow, or light, as practised in pictures seen by the means of reflected light.

The fact, as related by Bede, the Saxon chronicler, of the importation from France and Italy, into our own country, of artificers in glass, (A.D. 674,) by Wilfrid, Bishop of York, and Biscop his friend, had an important influence upon this branch of art in England. "When the work (of St. Peter's) was far advanced," writes Bede, "he sent agents to France to procure, if possible, some glass makers, a kind of artificers quite unknown in England, and to bring them over to glaze the windows of his church and monastery. These agents were successful, and brought several glass makers with them, who not only performed the work required by Benedict Biscop, but instructed the English in the art of making glass for windows, lamps, drinking vessels," &c.—Bede, Hist. Abbot. Weremuthen.

Emeric David states that the English, in their turn, instructed the Germans in this art.

While the influence of the style of the preceding ages was sensibly felt during the 14th century, the remarkable progress in the arts of painting and design before the close of that era greatly affected this art, while at the same time the route previously followed was not much deviated from. The Florentine and other schools of art had arisen in Italy.

Still the coloured and ornamented grounds prevailed, the painted windows in the cathedrals of Bourges, Clermont, Chartres, &c., show that the circles, flourishes, and other ornaments of the 11th century, described by Theophilus, yet held their places, but the subjects were better portrayed; to the experience of the past was added the new-born genius of Italy, and the art which the Byzantine Greeks had transmitted to Western Europe approached the summit of excellence.

I am not aware that the history of the processes of this period have been at all inquired into; in the little space afforded, in a work of this nature, I have endeavoured to collect a few practical directions from the manuscripts of the period. Bernard de Palissy,

[1] See Thibaud, Considerations sur les Vitraux anc. et mod. Paris, 1842. P. 105.

Leviel, de Piles, and other French writers are of a much later period, but will perhaps afford information if required. Neri appears to be the source from which most of these authors have drawn.

The relations which the Venetians held at a very early period with the East, and the constant intercourse they maintained with the Greeks of the lower empire, gave facilities in this art at a comparatively early period. The commerce they monopolised in white and coloured glass became an important feature in their statistics; this branch of industry and art might, with the command we possess of material and facilities, be developed to a great extent in this country.

There are many processes here described which will repay the trouble of perusal to the most scientific of our artists; those, however, are not of the class which would turn from any inquiry upon the subject during the present state of conflicting opinions, when the very principles of the art which formerly led to its perfection are questioned, or neglected.

The principles laid down by Theophilus must be studied by the glass painter and again placed as the foundation of his labours; modern chemistry has, doubtless, supplied him with means, in many instances far beyond what his predecessors have enjoyed, in the pursuit of this art, but there are yet conditions to be fulfilled which principally depend upon himself. The glass painter should well weigh the propriety of striving to rival the grey demi-tints of the oil painters, or aiming at the production of effects to which the nature of his art is in opposition[1]. It was from careful consideration and long experience that the art of glass painting became digested into the excellence of the 15th and 16th centuries; impotency, assuredly, had no share in principles followed. That the apparent simplicity of the methods of the Byzantine and Gothic glass painters, the powerful and harmonious effects resulting from a skilful arrangement and breadth of colour, to which Theophilus directs the attention of the artist, although allied to meagre invention, poor drawing, and incomplete execution, carried them triumphantly through their ordeal, the remains of the works, executed under the influence of this school, attest. When

[1] In offering these remarks the writer has only in view the grand, or church decoration; to the small subjects, calculated for our habitations, they will not universally apply, as these are viewed from a nearer point.

upon this foundation were superadded the pure and vigorous outline, and simple, elegant conception of the early Italian artists, the art appears to have reached a climax which it must have required an influence, as powerful as perverse, to depress.

The unfortunate rivality which existed between the glass and the oil painters appears to have had no small share in this; anxious to excel and emulative of accomplishing what had previously been, apparently, unattempted, the glass painters wandered from the legitimate conditions of their art in striving to rival the delicacy and gradations of the air tints, which they so much admired in the productions of their brother artists, totally forgetting that the means by which their works were rendered visible, a transmitted light, demanded a treatment so widely different. The experience of the past was neglected, and the art gradually sank, only to be revived by a return to the practice which elevated it.

LIBER TERTIUS.

INCIPIT LIBER TERTIUS.

THE BEGINNING OF THE THIRD BOOK.

INCIPIUNT CAPITULA.

CHAPTERS.

(The following chapters are not found in the index prefixed to the third book.)

PROLOGUS IN LIBRUM TERTIUM.

INCIPIT PROLOGUS

IN

LIBRUM TERTIUM.

EXIMIUS Prophetarum David, quem Dominus Deus præscivit ante tempora secularia et prædestinavit, quemque juxta simplicitatem et humilitatem mentis illius, secundum cor suum elegit, et sibi dilectæ plebi principem præposuit, utque regimen tanti nominis nobiliter et prudenter, disponeret, spiritu principali confirmavit, tota mentis intentione se colligens in amorem sui conditoris, hæc inter alia protulit: *Domine, dilexi decorem domus tuæ.* Et licet vir tantæ auctoritatis tamque capacis intellectus, domum hanc diceret habitationem cœlestis curiæ, in qua Deus hymnicis angelorum choris inæstimabili præsidet claritate, ad quam ipse totis visceribus anhelabat, dicens: *Unam petii a Domino, hanc requiram, ut inhabitem in domo Domini omnibus diebus vitæ meæ;* sive receptaculum devoti pectoris et purissimi cordis, cui vere Deus inhabitat, cujus hospitis desiderio idem flagrans orat: *Spiritum rectum innova in visceribus meis, Domine:* tamen ornatum materialis domus Dei, quæ locus est orationis, constat eum concupivisse.

PREFACE

TO

THE THIRD BOOK.

THE most renowned of the Prophets, David,—of whom the Lord had prescience, and whom he predestined before mundane ages, and whom, on account of the simplicity and humility of his mind, He elected, after his own heart, and placed over the people of his choice, and established with his Holy Spirit, that he might nobly and wisely regulate the conduct appertaining to so great a name,—concentrating within himself all the power of his soul in the love of his Maker, uttered these words amongst others:—"*Lord, I have loved the beauty of thy house.*" And although it was lawful that a man of so much authority and of such capacious intellect should call house that habitation of heavenly worship in which God presides in ineffable brightness over the hymns of choirs of angels, towards which he himself yearned with all his soul, saying, "*One thing have I desired of the Lord, that will I seek after; that I may dwell in the house of the Lord all the days of my life;*" or, as the refuge of a devoted breast and most pure heart, in which God truly dwelt, of which asylum an intense desire again prays forth, "*Renew a right spirit within me, O Lord*"—yet it is certain that he strongly desired the embellishment of the material house of God, which is the place of prayer.

Nam pene omnes impensas domus, cujus ipse auctor fieri ardentissimo desiderio concupivit, sed pro humani sanguinis licet hostili crebra tamen effusione non meruit, in auro, et argento, ære et ferro, Salomoni filio delegavit. Legerat namque in Exodo, Dominum Moysi de constructione tabernaculi mandatum dedisse, et magistros operum ex nomine elegisse, eosque spiritu sapientiæ et intelligentiæ et scientiæ in omni doctrina implesse ad excogitandum et faciendum opus in auro et argento et ære, gemmis, ligno, et universi generis arte, noveratque pia consideratione Deum hujusmodi ornatu delectari, quem construi disponebat magisterio et auctoritate Spiritus sancti, credebatque absque ejus instinctu nihil hujusmodi quemquam posse moliri. Quapropter, dilectissime Fili, non cuncteris, sed plena fide crede, spiritum Dei cor tuum implesse, cum ejus ornasti domum tanto decore, tantaque operum varietate; et ne fortè diffidas, nlin evi denti ratione, quicquid discere, intelligere, vel excogitare possis artium, septiformis spiritus gratiam tibi ministrare.

[1]Per spiritum sapientiæ cognoscis a Deo cuncta creata procedere, et sine ipso nihil esse; per spiritum intellectus cepisti capacitatem ingenii, quo ordine, qua varietate, qua mensura valeas insistere diverso operi; per spiritum consilii talentum a Deo tibi concessum non

[1] Nota conformationem septem spiritorum cum septem operum artibus.—*Ex MS. Harleo.*

For almost all the treasures in gold, silver, brass and iron of the house, whose founder he himself with such an ardent desire coveted to be made, yet of which he was not worthy, on account of the frequent effusion of human, although hostile, blood, he committed to his son Solomon. For he had read in Exodus that God had given a command to Moses for the construction of the tabernacle, and had selected by name the masters of the works, and that he had filled them with the spirit of wisdom and intelligence and science, in every knowledge, for inventing and executing work in gold and silver, and brass, gems, wood, and in art of all kinds; and he had discerned, by means of pious reflection, that God complacently beheld decoration of this kind, which He was appointing to be constructed under the teaching and authority of his Holy Spirit; and he believed that without His inspiration no one could mould any work of this kind. Therefore, most beloved son, you will not doubt, but believe with an entire faith, that the Spirit of God has filled your heart when you have adorned his temple with so much beauty, and with such variety of work; and that you may not chance to fear, I can prove, with clear reasoning, that whatsoever you may be able to learn, understand, or invent in the arts, is ministered to you as a gift of the sevenfold Spirit.

Through the spirit of wisdom you know that all created things proceed from God, and that without him nothing exists. Through the spirit of intelligence you have acquired the faculty of genius, in whatever order, in what variety, in what proportion, you may choose to apply to your varied work. Through the spirit of counsel you do not hide the talent conceded to you by God, but by

abscondis, sed cum humilitate palam operando et docendo, cognoscere cupientibus fideliter ostendis; per spiritum fortitudinis omnem segnitiei torporem excutis, et quicquid non lento conamine incipis, plenis viribus ad effectum perducis; per spiritum scientiæ concessum, ex abundanti corde dominaris ingenio, et quo perfectè abundas plenæ mentis audacia uteris in publico; per spiritum pietatis, quid, cui, quando, quantum vel qualiter operis, et ne subrepat avaritiæ seu cupiditatis vitium, mercedis pretium pia consideratione moderaris; per spiritum timoris Domini te nihil ex te posse consideras, nihil inconcessum a Deo te habere seu velle cogitas, sed credendo, confitendo, gratias agendo, quicquid nosti, vel es, aut esse potes, divinæ misericordiæ reputas.

His virtutum stipulationibus animatus, carissime Fili, domum Dei, fiducialiter aggressus, tanto lepore decorasti, et laquearia seu parietes diverso opere, diversisque coloribus distinguens paradysi Dei speciem floribus variis vernantem, gramine foliisque virentem, et sanctorum animas diversi meriti coronis foventem, quodammodo aspicientibus ostendisti, quodque creatorem Deum in creatura laudant, et mirabilem in suis operibus prædicant, effecisti. Nec enim perpendere valet humanus oculus, cui operi primum aciem infigat; si respicit laquearia, vernant quasi pallia; si considerat pa-

working and teaching openly, with humility, you faithfully expound to those desirous to learn. Through the spirit of perseverance you shake off all lethargy of sloth, and whatever with quick diligence you commence, you carry through with full vigour to the completion. Through the spirit of science accorded to you, you rule with genius from an abounding heart, and from that with which you entirely overflow you bestow with the confidence of a well-stored mind for the common good. Through the spirit of piety you regulate the nature, the destination, the time, the measure and the means of the work; and, through a pious consideration, the price of the fee, that the vice of avarice or covetousness may not steal in. Through the spirit of the fear of God you meditate that you can do nothing from yourself, but you consider that you possess, or will, nothing unconceded by God; but by believing, confiding and giving thanks, you ascribe to divine compassion whatever you have learned, or what you are, or what you may be.

Animated, dearest son, by these covenants with the virtues, thou hast confidently approached the house of God, hast decorated with the utmost beauty ceilings or walls with various work, and, showing forth with different colours a likeness of the paradise of God, glowing with various flowers, and verdant with herbs and leaves, and cherishing the lives of the saints with crowns of various merit, thou hast, after a fashion, shown to beholders everything in creation praising God, its Creator, and hast caused them to proclaim him admirable in all his works. Nor is the eye of man even able to decide upon which work it may first fix its glance; if it beholds the ceilings, they glow like draperies; if it re-

rietes, est paradysi species; si luminis abundantiam ex fenestris intuetur, inestimabilem vitri decorem et operis pretiosissimi varietatem miratur. Quod si fortè Dominicæ Passionis effigiem liniamentis expressam conspicatur fidelis anima, compungitur; si quanta sancti pertulerint in suis corporibus cruciamina, quantaque vitæ æternæ perceperint præmia conspicit, vitæ melioris observantiam arripit; si quanta sunt in cœlis gaudia, quantaque in tartareis flammis cruciamenta intuetur, spe de bonis suis[1] animatur, et de peccatorum consideratione formidine concutitur.

Age ergo nunc, vir bone, felix apud Deum et homines in hac vita, felicior in futura, cujus labore et studio Deo tot exhibentur holocausta, ampliori deinceps accendere sollertiâ, et quæ adhuc desunt in utensiliis domus Domini, ad explendum aggredere toto mentis conamine, sine quibus divina mysteria et officiorum ministeria non valent consistere. Sunt autem hæc: Calices, Candelabra, Thuribula, Ampullæ, Urcei, sanctorum pignerum Scrinia, Cruces, Plenaria et cætera, quæ in usum ecclesiastici ordinis poscit utilitas necessaria.

Quæ si vis componere, hoc incipias ordine.

[1] "Actibus" *interponitur in Codice Guelpherbytano.*

EXPLICIT PROLOGUS.

gards the walls, there is the appearance of paradise; if it marks the abundance of light from the windows, it admires the inestimable beauty of the glass and the variety of the most costly work. But if perchance a faithful mind should behold a representation of our Lord's passion expressed in drawing, it is penetrated with compunction; if it beholds how many sufferings the saints have bodily supported, and how many rewards of eternal life they have received, it quickly induces the observance of a better life; if it regards how much rejoicing is in heaven, and how much suffering in the flames of hell, it is animated by hope for its good actions, and is struck with fear by the consideration of its sins.

Act therefore now, well-intentioned man, happy before God and men in this life, happier in a future, in whose labour and study so many sacrifices are offered up to God; henceforth warm thyself with a more ample invention, hasten to complete with all the study of thy mind those things which are still wanting among the utensils of the house of the Lord, without which the divine mysteries and the services of ceremonies cannot continue. These are the chalices, candelabra, incense burners, vials, pitchers, caskets of sacred relics, crosses, missals and other things which useful necessity requires for the use of the ecclesiastical order.

If you wish to fabricate these, in this order you commence.

END OF THE PREFACE.

INCIPIT LIBER TERTIUS.

CAPUT I.

DE CONSTRUCTIONE FABRICÆ.

ÆDIFICA tibi domum spatiosam et altam, cujus longitudo ad orientem tendatur, in cujus pariete meridiano facies fenestras quot volueris et possis, ita ut inter duas fenestras quinque pedes sint. Divide autem medietatem domus ad opus fusile faciendum, et cuprum ac stagnum et plumbum operandum, uno pariete usque ad summitatem altitudinis, et rursum divide quod reliquum est in duo in uno pariete, ad operandum in una parte aurum, in altera argentum. Fenestræ vero non emineant altius a terra quam uno pede, quarum altitudo sit trium pedum, latitudo duorum.

CAPUT II.

DE SEDE OPERANTIUM.

DEINDE fode fossam ante fenestram, a pariete fenestræ pede et dimidio, quæ stabit in transverso, habens longitudinis trium pedum, latitudinis duorum, quam texes in circuitu lignis, quorum lignorum duo in medio contra fenestram procedant a fossa altitudine dimidii pedis, super quæ jungatur discus unus qui cooperiat genua sedentium in fossa, latitudine duorum pedum, longitudine trium, in transverso super fossam, ita æqualis, ut quicquid minutim auri vel argenti desuper ceciderit, possit diligenter scopari.

THE BEGINNING

OF

THE THIRD BOOK.

CHAPTER I.

OF THE CONSTRUCTION OF THE WORK BUILDING.

Build a spacious and lofty house for yourself, the length of which must stretch towards the east; in the southern wall of which make as many windows as you wish and are able, so as five feet may exist between two windows. But separate half of the house, for making molten work, and for working copper, tin and lead, by a wall reaching to the summit; and again divide that part left into two, by one wall, for working gold in one part, silver in the other. The windows must not rise higher than a foot from the ground; let their height be three feet, their width two.

CHAPTER II.

OF THE SEAT OF THE WORKMEN.

Then dig a trench before the window, a foot and a half from the wall of the window, which (trench) will stand across, having the length of three feet, the width of two, which you line around with wood; two pieces of which wood can protrude from the trench, in the centre opposite the window, to the height of half a foot, upon which a table, which may cover the knees of those seated in the trench, is joined, in breadth two feet, in length three, crosswise over the trench, so smooth, that whatever particles of gold or silver may have fallen upon it may be carefully collected.

CAPUT III.

DE FORNACE OPERIS.

JUXTA parietem vero prope fenestram in sinistra parte sedentis, figatur lignum in terram[1], latitudine duorum, spissitudine pene duorum digitorum, quod cum firmiter steterit, habeat foramen grossitudine unius digiti in medio, a terra altitudine quatuor digitorum. Habeat quoque in anteriore parte lignum strictum sibi conjunctum, et clavis ligneis affixum, latitudine quatuor digitorum, cujus longitudo æquetur majori ligno. Ante quod stabilies aliud lignum æquæ latitudinis et longitudinis, ita ut inter hæc duo ligna sit amplitudo quatuorum digitorum, et affige illud exterius duobus aut tribus paxillis, et acceptâ argillâ non maceratâ nec aquâ mixtâ, sed noviter effossâ, mitte in illud spatium in primis modicum, et compinge cum ligno rotundo fortiter, deinde amplius, et iterum percute, sicque facies donec duæ partes ipsius spatii impleantur, et tertiam dimitte vacuam. Tunc aufer anterius lignum, et cum cultello longo incide argillam æqualiter ante et sursum, deinde cum gracili ligno percute fortiter. Post hæc accipe argillam maceratam et fimo equi mixtam, et compone fornacem et larem ejus, tegens parietem, ne uratur igne, et cum gracili ligno perfora argillam trans foramen quod est retro in ligno. Hoc modo compone omnes fornaces fabriles.

CAPUT IV.

DE FOLLIBUS.

DEINDE fac tibi folles de pellibus arietum ita. Cum occiduntur arietes, non incidantur pelles sub ventre, sed in posterioribus aperiantur, et ita eversentur ut integræ extra-

[1] "longitudine trium pedum." *Ex MS. Guelph.*

CHAPTER III.

OF THE WORK FURNACE.

Near the wall, by the window, on the left side of the person sitting, a piece of wood is fixed in the ground (three[1] feet in length) in width two and in thickness scarcely two fingers, which, when it is firmly fixed, may have a perforation in the midst of the size of a finger, four fingers high above the ground. Let it have also in front a straight piece of wood joined to it, and fixed with wooden pegs, four fingers in breadth, and the length of which is equal to the large piece of wood. In front of this you fasten another wood of equal breadth and length, so that between these two woods there may be a space of four fingers, and fasten that outside by two or three stakes; and taking clay, not beaten, nor mixed with water, but newly dug up, put at first a little of it into this space, and compress it strongly with a rounded piece of wood, then more, and again beat it; and do thus until two parts of this space are filled, and leave the third empty. Then take away the wood in front, and with a long knife cut the clay evenly in front and on the top, then with a thin piece of wood beat it strongly. After this take clay beaten and mixed with horse dung, and make the furnace and its hearth, covering the wall that it may not be burned by the fire, and with a slender pieee of wood perforate the clay through the opening which is in the wood behind. In this manner compose all smith's furnaces.

CHAPTER IV.

OF THE BELLOWS.

Then make bellows from the skins of rams, thus:—When the rams are killed, the skins must not be cut under the belly, but they are opened behind, and are so turned over that they

[1] *From the Wolfenbüttel Manuscript.*

hantur, et impletæ stramine modice exsiccentur. Postea jaceant in confectione fæcis et salis una die et duabus noctibus, tertia vero die trahantur in retorta in longitudine, sed plus in latitudine. Deinde ungantur et iterum trahantur. Posthæc fiat folli caput ligneum, quod transeat per collum ejus et ibi ligetur, et in capite foramen per quod transeat fistula ferrea. Retro vero in latitudine follis ponantur quatuor ligna, quorum duo sibi conjungantur et colligentur in medio, et duo sibi deinde suantur in folle ita, ut juncturæ in medio sint superius et inferius, ubi etiam duæ ansæ ex eadem pelle consuantur, una superius minor, in qua pollex imponatur, altera major inferius, ubi reliqui quatuor digiti immittantur. His completis pone fistulam ferream in foramen fornacis, et retro et ante fornacem carbones et ignem, et suffla ut fornax exsiccetur. Utensiliorum autem et ferramentorum nomina in fabrili opere sunt hæc.

CAPUT V.

DE INCUDIBUS.

INCUDES latæ, æquales et quadræ. Item incudes æquales et cornutæ. Item incudes superius rotundæ in similitudine dimidii pomi, una major, alia minor, tertia brevis, qui vocantur nodi. Item incudes superius longæ et strictæ quasi duo cornua ab hastili præcedentia, quorum unum sit rotundum et deductum ita, ut in summitate sit gracile, aliud vero latius et in summitate modice recurvum in rotunda æqualitate ad similitudinem unius pollicis. Hæ sunt majores et minores.

may be stripped off whole, and being filled with straw, they are moderately dried. Afterwards they are thrown into a preparation of lye and salt for a day and two nights, the third day they are stretched lengthwise, but more in breadth. Then they are anointed and again stretched. After this the wooden head to the bellows is made, which passes through its neck and is there bound, and in this head a perforation through which an iron tube may pass. But behind, in the width of the bellows, four pieces of wood are placed, of which two are joined together and fixed in the middle; and two are sewed upon the bellows together, so that the joinings in the middle may be above and below; where also two loops of the same skin are sewed on, the one above smaller, in which the thumb is placed, the other larger below, where the other four fingers are put. These things finished, place the iron tube in the hole of the furnace, and fire and charcoal at the back and front of the furnace, and blow, that the furnace may become dry. The names of utensils and iron instruments, in work of fusion, are these.

CHAPTER V.

OF ANVILS.

Anvils, flat, smooth and square. Also anvils even and horned. Also anvils round at the top, like half an apple, one large, another smaller, a third short, which are called knots. Also anvils long and narrow on the top, like two horns proceeding from a spear, of which one may be rounded and diminishing so that it be pointed at the end, but the other broader and slightly turned round at the end with round smoothness, like a thumb. These are made large and small.

CAPUT VI.

DE MALLEIS.

MALLEI multi, majores, minores et parvi, in una parte lati, in altera stricti. Item mallei longi et graciles in summitate rotundi, majores et minores. Item mallei superius cornuti, inferius lati.

CAPUT VII.

DE FORCIPIBUS.

FORCIPES manuales fortes, habentes nodos in summitate, majores et minores. Item forcipes longi et graciles. Item forcipes fusorii longi, et in anteriori parte modicum curvi. Item forcipes mediocres, quibus limanda quæque teneantur, qui sint in summitate unius caudæ graciles, in altera pendeat ferrum tenue et latum, ac perforatum, cui cum posueris aliquid parvum limandum, comprime fortiter, et mitte gracilem caudam in quod foramen volueris. Item forcipes parvuli, in una summitate sibi adhærentes, et in altera graciles, quibus grana et alia quæque minuta componantur. Item forcipes, qui dicuntur carbonarii, et majores et minores, quæ sint in una summitate integri et plicati, in altera aperti et modice curvi. Item forcipes incisorii majores et minores, in duabus partibus compositi et clavo confixi.

CAPUT VIII.

DE FERRIS PER QUÆ FILA TRAHUNTUR.

FERRI duo latitudine trium digitorum, superius et inferius stricti, per omnia tenues, et tribus ordinibus aut quatuor perforati, per quæ foramina fila trahantur.

CHAPTER VI.

OF HAMMERS.

MANY hammers, large, middling and small, at one end flat, at the other narrow. Also long and slender hammers round at the end, large and small. Also hammers horned at the top, wide at the bottom.

CHAPTER VII.

OF PINCERS.

STRONG hand pincers, having knobs at the top, large and smaller. Also long and slender pincers. Also founders' pincers, long and slightly curved at the upper end. Also pincers of moderate size, with which any things to be filed are held, which must be slender at the top of one of the branches, and at the other must hang a thin and broad piece of iron, and perforated, in which when you place any thing small for filing you press strongly, and place the slender branch in any opening you please. Also very small pincers united together at one extremity and slender at the other, with which beads and other minute things are arranged together. Also pincers which are called coal-pincers, both large and small, which must be entire and bent at one end, open and slightly curved at the other. Also cutting pincers, large and small, made in two parts, and fastened together by a rivet.

CHAPTER VIII.

OF THE INSTRUMENTS THROUGH WHICH WIRES ARE DRAWN.

Two irons three fingers in breadth, narrow above and below, everywhere thin, and perforated with three or four ranges, through which holes the wires are drawn.

CAPUT IX.

DE INSTRUMENTO QUOD ORGANARIUM DICITUR.

EST etiam instrumentum ferreum, quod organarium dicitur, quod constat duobus ferris, uno inferius, altero superius; sed pars inferior habet grossitudinem et longitudinem longioris digiti, et est aliquantulum tenuis, habens duo hastilia, quibus lignum figitur inferius, supra quæ in superiori parte eminent duo clavi grossi, qui suscipiunt superiorem partem ferri, quod ferrum habet grossitudinem et longitudinem inferioris, et habet duo foramina, in utraque summitate unum, per quæ duo clavi[1] superiores inducantur, ut sibi conjungantur. Valde enim conjungi debent cum lima; in quibus utrisque fodiantur fossulæ, ita ut per medium appareant foramina, ut cum in majori argentum vel aurum mittitur longum et æqualiter rotundum percussum, feriatur superior pars ferri fortiter cum malleo corneo, et altera manu rotetur aurum vel argentum, et fiant grana rotunda sicut fabæ, in sequenti foramine fiant quasi pisa, in tertio quasi lentes, et sic minora.

CAPUT X.

DE LIMIS INFERIUS FOSSIS.

FIUNT etiam ferri graciles ut festuca, longitudine unius digiti, quadri; sed in uno latere latiores, quorum caudæ, in quibus manubria ponuntur, sunt sursum curvæ; inferius autem per longitudinem est tractus fossus et limatus quasi sulcus, et ex utraque parte ejus sunt costæ acutæ limatæ. His ferris limantur fila aurea et argentea grossa et subtilia, ita ut in eis grana appareant.

[1] "inferiores?" *Transl.*

CHAPTER IX.

OF THE INSTRUMENT WHICH IS CALLED THE ORGANARIUM.

There is also an iron instrument called the organarium, which consists of two irons, an under and upper; but the lower part has the size and length of the middle finger, and is somewhat slender, having two points to which wood is fixed below, over which, at the upper part, protrude two long nails, which receive the upper part of the instrument; this iron has the size and length of the one underneath, and has two perforations through which the two lower[1] nails may be conducted, that they (the irons) may be joined together. They should also be well joined together with the file, and in both of them small grooves should be hollowed out, so that the holes may appear through the middle, so that when silver or gold, smoothly beaten long and round, is placed in the larger (groove), the upper part of the instrument is strongly struck with the horned hammer, and the gold or silver is turned round with the other hand, and round beads like beans are made; in the next furrow they are made like peas, in the third like lentils, and so on smaller.

CHAPTER X.

OF FILES HOLLOWED UNDERNEATH.

Slender irons are also made like straws, a finger in length, rectangular, but on one side wider, the ends of which, upon which the handles are placed, are curved upwards; but underneath, lengthwise, a groove is traced, and is filed like a furrow, and on both sides of it sharp ribs are filed. With these instruments golden and silver wires, thick and fine, are filed, so that beads may appear upon them.

[1] The manuscript has "*superiores*," "upper;" this is evidently an inadvertence. *Transl.*

CAPUT XI.

DE FERRIS FOSSORIIS.

FIUNT quoque ferri fossorii ad fodiendum hoc modo. Fit ferrum ex calibe puro, longitudine majoris digiti, et grossum ut festuca, in medio vero grossius, et est quadrum; una cauda ponitur in manubrium, et alterâ summitate limatur una costa, quæ est superior, usque ad inferiorem, sed inferior est longior, quæ limata gracilis est in cuspide; quod calidum temperatur in aqua. Ad hanc speciem fiunt plures majores et minores. Fit et aliud similis quadrum, sed est latius et tenue, cujus acumen sit in ipsa latitudine, ita ut duæ costæ sint superius et duæ inferius longiores et æquales. Hoc quoque modo fiunt plures parvi et magni. Fit etiam ferrum rotundum et grossum sicut festuca, cujus cuspis ita limatur, ut tractus, quem facit, sit rotundus.

CAPUT XII.

DE FERRIS RASORIIS.

FIUNT etiam ferri rasorii graciles, sed in fine aliquantulum latiores, una parte acuti, parvi et magni, quorum aliqui fiunt recurvi, pro libitu secundum modum operis. Fiunt etiam ferri eodem modo formati, sed obtusi ad poliendum opus.

CAPUT XIII.

DE FERRIS AD DUCTILE OPUS APTIS.

FIUNT quoque ferri ad exprimendas imagines, aves, bestias, sive flores, ductiles in auro et argento et cupro, longitudine unius palmi, superius lati et capitati, inferius vero

CHAPTER XI.

OF SCULPING INSTRUMENTS.

Sculping irons are also made for hollowing out in this manner. An instrument is made from pure steel, the length of the great finger, and as thick as a straw, but thicker in the middle and square. One end is placed in a handle, and at the other end one side must be filed from the upper to the lower angle; but the lower, which is filed slender towards the point, is longer; this being heated, is tempered in water. Many larger and smaller are made after this fashion. Another like kind is made square, but more broad and thin, and its edge is parallel with the breadth, so that two angles are above, and the two below more long and equal. In this fashion also many large and small are made. A round and thick iron like a straw is also made, the point of which is filed so that the mark which it makes be round.

CHAPTER XII.

OF SCRAPING INSTRUMENTS.

Slender scraping irons are likewise made, but somewhat broad at the end, sharp on one side, large and small, of which some are made curved back at will, according to the mode of work. They make also instruments formed in the same manner, but blunt, for polishing the work.

CHAPTER XIII.

OF INSTRUMENTS FIT FOR MALLEABLE WORK.

Instruments also are made for portraying figures, birds, animals, or flowers beaten in gold, and silver, and copper; thees are a palm in length, wide and headed at the upper

graciles, rotundi, tenues, trianguli, quadranguli, recurvi, prout expetit varietas operis formati, qui malleo debent percuti. Fit vero ferrum eodem modo formatum, sed gracile in fine, in quo est foramen altero ferro graciliore inditum, et in circuitu limatum, quod cum percussum fuerit in auro vel argento sive cupro deaurato, apparet quasi subtilissimus circulus.

CAPUT XIV.

DE FERRIS INCISORIIS.

FIUNT quoque ferri incisorii talis magnitudinis, ut plena manu teneantur, et super manum emineant, lati et æquales, inferius etiam manum excedant, lati, tenues et acuti. Horum fiunt multi parvi et magni, quibus inciditur aurum et argentum sive cuprum spissum.

CAPUT XV.

DE FERRIS AD FACIENDOS CLAVOS.

SUNT et ferri tenues et stricti perforati, in quibus clavi capitantur, magni, mediocres et parvi.

CAPUT XVI.

DE FERRIS INFUSORIIS.

SUNT etiam ferri infusorii, longi, rotundi et quadri, in quibus funditur liquefactum aurum, argentum vel cuprum. Sunt et circini ferrei duabus partibus compositi, majores et minores, recti et curvi.

part, but at the lower end slender, round, thin, triangular, quadrangular, curved back, as the variety of form of the work demands; these should be struck with the hammer. An iron is also made formed in the same manner, but fine at the end, in which a hole is inserted by another more pointed instrument and filed around, which, when it has been struck upon gold, or silver, or copper gilt, causes a very delicate circle to appear.

CHAPTER XIV.

OF CUTTING INSTRUMENTS.

Cutting instruments are also made broad and even, of such a size that they may be held in the whole hand, and that they may rise above the hand: they even extend below the hand broad, thin and sharp. Many of these are made large and small; with these gold is cut, and silver, or thick copper.

CHAPTER XV.

OF IRONS FOR MAKING NAILS.

There are also irons thin and pierced narrowly, in which nails are headed, large, middling and small.

CHAPTER XVI.

OF IRON MOULDS.

There are likewise moulds of iron, long, round and square, into which melted gold, silver, or copper is poured. There are also iron compasses made in two parts, large and small, straight and curved.

CAPUT XVII.

DE LIMIS.

LIMÆ vero fiunt ex puro calibe, magnæ et mediocres[1], trium costarum et rotundæ. Fiunt et aliæ, ut fortiores sint in medio, interius ex molli ferro, exterius vero co-operiuntur calibe. Quæ cum percussæ fuerint secundum magnitudinem, quam eis auctor earum dare voluerit, æquantur super runcinam, sicque inciduntur cum malleo ex utraque parte acuto. Inciduntur etiam aliæ cum ferro incisorio, de quo supra diximus; cum quibus æquari debet opus, quod cum aliis grossioribus prælimatum fuerit. Cumque ex omni parte incisæ fuerint, fac temperamentum hoc modo.

CAPUT XVIII.

DE TEMPERAMENTO LIMARUM.

COMBURE cornu bovis in igne et rade, atque misce ei tertiam partem salis, et tere fortiter. Deinde mitte limam in ignem, et cum canduerit, salies illam confectionem super eam ex omni parte, aptisque carbonibus valde ardentibus cum festinatione sufflabis per omnia sic ut temperamentum non cadat, et statim eiciens[2] siccabis modice super ignem. Hoc modo temperabis omnes quæ sunt ex calibe.

CAPUT XIX.

ITEM UNDE SUPRA.

FACIES et parvulas similiter quadras[3], rotundas, triangulas, tenues ex molli ferro, easque sic temperabis. Cum incisæ

[1] "ut quadræ," *ex MS. Guelph.*
[2] "extingue æqualiter in aqua et inde eiciens," *ex Codice Guelph.*
[3] "semirotundas," *ex Cod. Guelph.*

CHAPTER XVII.

OF FILES.

FILES are made from pure steel, large and moderately sized, triangular and round. Others also are made which are stronger in the middle, from soft iron inside, but outwardly they are covered with steel; which, when they have been beaten to the size which the maker wishes to give them, are made smooth upon a planing instrument, and are thus marked out with a hammer, which is sharp on both sides. They are also marked out with the cutting iron, of which we have spoken above, with which the work, which has previously been filed with the other larger irons, should be smoothed. And when they have been cut all over, make their tempering in this way.

CHAPTER XVIII.

OF TEMPERING FILES.

BURN the horn of an ox in the fire, and scrape it, and mix with it a third part salt, and grind it strongly. Then put the file in the fire, and when it glows sprinkle this preparation over it everywhere, and, some hot coals being applied, you will blow quickly upon the whole, yet so that the tempering may not fall off, and quickly withdrawing it[1], extinguish it equally in water, and taking it out, dry it slightly over the fire. You will in this manner temper all things which are made of steel.

CHAPTER XIX.

THE SAME AS THE PRECEDING.

MAKE also smaller files, similarly square, round, triangular, thin, from soft iron, and you will thus temper them. When

[1] *From the Wolfenbüttel Manuscript.*

fuerint cum malleolo, sive cum incisorio ferro, aut cum cultello, unges eas veteri aruina porci, et circumdabis corrigiolis ex hircino corio incisis, ligabisque filo lineo. Posthæc cooperies eas argillâ maceratâ singulariter, caudasque nudas dimittes. Cumque siccatæ fuerint, mittes in ignem, et sufflabis fortiter, combureturque corium, et cum festinatione extrahens ab argilla extingues, æqualiter in aqua, extractasque siccabis ad ignem.

CAPUT XX.

DE TEMPERAMENTO FERRI.

FERRI quoque fossorii temperantur hoc modo. Cum limati fuerint et suis manubriis aptati, summitas eorum mittitur in ignem, et mox ut cœperit candescere, extrahitur et in aqua extinguitur.

CAPUT XXI.

ITEM DE EODEM.

FIT etiam aliud temperamentum ferramentorum, quibus vitrum inciditur et molliores lapides hoc modo. Tolle hircum triennem, et liga eum intus tribus diebus sine cibo, quartâ die da ei filicem comedere et nichil aliud. Quem cum duobus diebus comederit, sequenti nocte co-operi eum in dolio inferius perforato, sub quibus foraminibus pone aliud vas integrum, in quo colligas urinam ejus. Qua duabus vel tribus noctibus tali modo sufficienter collecta, emitte hircum, et in ipsa urina ferramenta tua tempera. In urina etiam rufi pueri parvuli temperantur ferramenta, durius quam in aqua simplici.

they have been cut out with the small hammer, or cutting iron, or with a knife, anoint them with the grease of an old hog, and bind them round with small straps cut from the skin of the buck-goat, and tie them with flaxen thread. Afterwards cover them one by one with beaten clay, and leave the handles bare. And when they are dry place them in the fire, and blow strongly, and the skin is burned; and quickly taking them from the clay, extinguish them equally in water, and, being taken out, you will dry them at the fire.

CHAPTER XX.

OF TEMPERING IRON.

Grooving irons are likewise tempered in this manner. When they have been filed and fitted in their handles, their end is placed in the fire, and presently, when it has begun to glow, it is taken out and quenched in water.

CHAPTER XXI.

OF THE SAME.

Another kind of tempering of iron instruments is also made in this manner, by which glass is cut, and also the softer stones. Take a three year old buck-goat, and tie him up within doors for three days without food; on the fourth day give him fern to eat and nothing else. When he shall have eaten this for two days, on the night following enclose him in a cask perforated at the bottom, under which holes place another sound vessel in which you can collect his urine. Having in this manner for two or three nights sufficiently collected this, turn out the buck, and temper your instruments in this urine. Iron instruments are also tempered in the urine of a young red-haired boy harder than in simple water.

CAPUT XXII.

DE VASCULIS AD LIQUEFACIENDUM AURUM ET ARGENTUM.

HÆC omnia præ manibus habens, accipe argillam albam, et tere eam minutissime, acceptisque vasis veteribus in quibus aurum vel argentum prius infusum fuerit, comminue singulariter. Quæ si non habeas, accipe testulas ollæ albæ, et mitte eas in ignem donec candescant, et si non resiliunt, sine refrigerari et tere singulariter. Deinde pone duas partes argillæ tritæ et[1] quartam coctæ testæ, et commisceas cum aqua tepida, macera fortiter, et inde compone vascula majora et minora, in quibus liquefacias aurum et argentum. Interim vero, dum siccantur, acceptâ staterâ pondera aurum vel argentum, quod operari volueris. Quod si argentum purum non fuerit, hoc modo purifica.

CAPUT XXIII.

DE PURIFICANDO ARGENTO.

CRIBRA cineres, commiscens eos aquâ, et accipe testam ollæ in igne probatam, quæ tantæ magnitudinis sit, in qua credas argentum liquefieri posse, quod purificari debet, ut non effundatur, et mitte cineres in eam, in medio tenues et circa oram spissos, et sicca ad carbones. Qua siccata amove carbones a fornace modicum, et pone ipsam cum cineribus sub foramine ante fornacem, sic ut ventus ex folle in eam flet, superpositisque carbonibus suffla donec candescat. Deinde mitte argentum in eam, et superpone modicum plumbi, superjectisque carbonibus liquefac illud, et habeas juxta te virgam ex sepe vento siccatam, cum qua discooperies diligenter, et

[1] "tertiam," *ex MS. Guelph.*

CHAPTER XXII.

OF CRUCIBLES FOR MELTING GOLD AND SILVER.

HAVING all these things ready to your hands, take white clay and grind it very fine, and old vases, in which gold or silver has been before melted; being taken, break them up separately. If you have not these, take baked fragments of white earthen pots, and put them in the fire until they glow, and if they do not crack allow them to cool and grind them apart. Then put two parts of the ground clay and a fourth[1] part of the burnt pot fragments, and mix it with warm water, beat it strongly, and make crucibles large and small of it, in which you can melt gold and silver. And in the mean time, while they are drying, taking the balance, weigh the gold or silver which you wish to be worked. But if the silver be not pure, purify it in this manner.

CHAPTER XXIII.

OF PURIFYING SILVER.

SIFT ashes, mixing them with water, and take an earthen vessel proved in the fire, which must be of such a size as you think the silver, which is to be purified, can be melted in, so that it may not be scattered, and put the ashes into it, slightly in the middle, but thick round the border, and dry it upon the coals. Being dry, remove the coals a little from the furnace, and place it with the ashes under the opening before the furnace, so that the wind from the bellows may flow into it, and the coals being placed over it, blow until it glows. Then place the silver in it, and superpose a little lead, and, the coals being heaped over it, melt it, and have near you a rod cut from the hedge and dried in the wind, with

[1] "a third," *in the Wolfenbüttel MS.*

purgabis ab argento quicquid immunditiæ super illud videris, positoque super illud titione, hoc est ligno igne usto, sufflabis mediocriter longo tractu. Cumque plumbum hoc facto ejeceris, si videris argentum nondum purum esse, rursum ad pone plumbum, superpositisque carbonibus fac sicut prius. Quod si videris argentum ebullire et exsilire, scito stagnum vel aurichalcum ei admixtum, et confringe particulam vitri minute, et proice super argentum, plumbumque adde, appositis carbonibus fortiter suffla. Deinde respice sicut prius, et cum virgula aufer immunditiam vitri et plumbi, superpositoque titione fac sicut prius, et hoc tamdiu donec purum fiat.

CAPUT XXIV.

DE DIVIDENDO ARGENTO AD OPUS.

QUO purificato si calicem fabricare volueris, divide argentum æqualiter in duo, et medietatem serva ad faciendum pedem et patenam; ex altera vero facies vas, cui adicies ex portione patenæ partem; verbi gratia, si marca argenti fuerit, adde medietati, pondus duodecim nummorum, quos postea inde limabis et rades ut reddas suæ parti. Quod si plus fuerit argenti vel minus, secundum suam quantitatem addes, et post hæc unicuique parti suum pondus reddes.

CAPUT XXV.

DE FUNDENDO ARGENTO.

HIS ita dispositis mitte argentum in uno vasculorum, et cum liquefactum fuerit, proice modicum salis super illud, moxque effunde infusorium rotundum quod sit calefactum super ignem, et sit in eo cera liquefacta. Et si aliquâ negli-

which you will carefully uncover it, and will cleanse from the silver whatever impurity you may see upon it; and placing a fire-brand upon it, that is, wood burnt in the fire, you will blow moderately upon it with a long stroke. And when you have cast out all the lead by this process, if you see that the silver is not yet pure, again add lead, and the coals being superposed, do as before. But if you see the silver boil up and fly out, know that tin or brass is mixed with it; and break up a small piece of glass very finely, and throw it upon the silver and add lead; the coals being superposed, blow strongly. Then examine it as before, and with the rod remove the impurity of glass and lead, and the charcoal being placed upon it, do as before, and this until at length it is made pure.

CHAPTER XXIV.

OF THE DIVISION OF THE SILVER FOR THE WORK.

This being purified, if you wish to fabricate a chalice, divide the silver equally in two, and keep one half for making the foot and the plate; from the other you make the cup, to which you add a portion from the part of the plate; for example, if there be a mark of silver, add to the half the weight of twelve nummi, which you will afterwards file and scrape, that you may give it to its portion. But should there be more or less silver, you add, according to its quantity, and afterwards you restore its weight to each part.

CHAPTER XXV.

OF MELTING THE SILVER.

These things thus arranged, put the silver into one of the small crucibles, and when it is liquefied throw a little salt upon it, and directly pour it into the round mould, which is made warm over the fire, and in which there is melted wax,

gentiâ contigerit, ut argentum fusum sanum non sit, iterum funde, donec sanum fiat[1].

CAPUT XXVI.

DE FABRICANDO MINORE CALICE.

CUMQUE cœperis percutere, quære meditullium in eo, et fac centrum cum circino, et circa eum facies caudam quadram, in qua pedem configere debes. Cum vero sic attenuatum fuerit, ut manu plicari possit, fac interius circulos cum circino a centro usque in medium, et exterius a medio usque ad oram; et cum rotundo malleo percute interius secundum circulos, ut inde profunditatem capiat, et exterius cum mediocri super rotundam incudem secundum circulos usque ad oram, ut inde strictius fiat; et hoc tamdiu fac donec ei formam et amplitudinem secundum argenti quantitatem acquiras. Quo facto rade interius et exterius æquè cum lima, et circa oram, donec equalis per omnia fiat. Deinde residuam medietatem argenti sicut supra divide in duo, et ab una parte aufer pondus sex nummorum, et adde alteri, in qua pedem facies, quod postea inde limando auferes et suæ parti reddes. Sicque funde et percute pedem sicut vas, usque dum attenuetur, excepto quod caudam non facies in eo. Quo attenuato profunditatem dabis ei cum malleo rotundo interius et exterius, incipiesque nodum formare cum mediocri malleo super rotundam incudem, et inde super longam ex utraque parte, donec collum tam gracile facias sicut volueris; hoc diligenter procurans, ne plus in uno loco percutias quam in altero, ne fortè nodus se in aliquam partem inclinet, sed in medio stet, ex omni parte æquè spissus et latus. Deinde pone eum super carbones, et

[1] "Deinde fac tibi confectionem ex fæcibus claris et sale, in qua extingues argentum quotiens recoxeris." *Ex MS. Guelph.*

and if by some negligence it should happen that the melted silver be not whole, cast it again until it is made whole [1]. [Then make the mixture from clear lye and salt, in which you quench the silver as often as you remelt it.]

CHAPTER XXVI.

OF MAKING THE SMALLER CHALICE.

AND when you have begun to beat it, find the middle of it, and mark a centre with the compass, and around it make a square projection, in which you should fasten the foot. But when it has been made so thin that it can be bent with the hand, make circles inside with the compass from the centre to the middle, and outside, from the middle to the rim, and with a round hammer beat it inside according to the circles, that thus it may acquire depth, and outside with a middle-sized (hammer) upon a round anvil according to the circles as far as the rim, that it may thus become more narrow, and do this until at length you attain for it a form and capacity according to the quantity of silver. Which being done, rasp the inside and out smoothly with a file, and round the mouth until it is made even throughout. Then divide the remaining half of the silver in two, as above, and from one portion take away the weight of six nummi, and add it to the other from which you make the foot, which afterwards in filing you will take away from it and restore to its portion. And thus cast and hammer the foot, as the cup, until it is at length thinned, excepting that you do not make a projection in it. Being thinned you will give it depth, inside and out, with the round hammer, and will begin to form the knot with the middle-sized hammer upon the round anvil, and then upon one lengthened upon both sides, until you make the neck as slender as you wish, having a careful regard to this, that you do not hammer more in one place than in another, that the knot may not by chance lean upon either side, but stand in the middle, everywhere equally thick and wide. Then place it upon the coals and fill it with

[1] *From the Wolfenbüttel MS.*

imple cerâ, et cum refrigerata fuerit, tene ipsum pedem in sinistra manu, et in dextera ferrum unum ductile ac tenue; et fac puerum sedere juxta te, qui percutiat cum parvulo malleo super ferrum in quocunque loco illud posueris, et inde designabis anulum, qui inter nodum et pedem in circuitu esse debet. Quo designato effunde ceram et recocto pede iterum imple, ut anulum profundius percutias sicut prius; sicque facies donec eum æqualiter cum suis granis perficias. Deinde lima nodum et rade, et circa pedem interius et exterius, et oram ejus; sicque facies in medio nodi foramen quadrangulum secundum quantitatem caudæ superioris vasis, et in eo pones spissam partem argenti, rotundam, eodem modo perforatam. Facies quoque anulum singulariter, qui stare debet inter nodum et vas superius, eadem quantitate et specie sicut est ille, quem ductili ferro formasti sub nodo, et accipiens ferrum obtusum fricabis super cotem æqualem, deinde super ligneum quercineum, imposito ei carbone trito, et cum eo polies ipsum vas interius et exterius, nodum et pedem et anulum, sicque fricabis cum panno et cretâ subtiliter rasâ, donec omnino lucidum fiat opus. His ita peractis finde caudam vasis in quatuor usque in medium cum lima tenue, et eversa eum super incudem rotundam ita ut æqualiter pendeat, et superpone ei anulum, et in foramine nodi caudam, particulasque quæ in est desuper et tenens hæc cum sinistra manu fortiter et æqualiter, et in dextera ferrum ductile mitte in nodum et fac superius percuti cum malleo mediocri donec configas firmiter. Postea funde argentum, quod limasti et rasisti cum eo quod residuum est, et percute rotulam cum circino æquatam tantæ latitudinis quanta est altitudo calicis a pede inferius usque ad oram superius, et modice amplius, et sic percute cavum interius secundum latitudinem vasis superius, ita ut æqualiter possit in eo jacere. Et si volueris, fac circulos duos interius cum circino, et per-

wax, and when it has become cold, hold the foot itself in the left hand, and in the right an iron, yielding and thin, and make the boy sit near you, who can strike with a very small hammer upon the iron in whatever spot you place it, and you will mark the ring with it, which should be around it between the knot and the foot. Being designed, pour out the wax, and the foot being warmed fill it again, so that you may hammer the ring more deeply than before; and act thus until you perfect it equally, with its beads. Then file and scrape the knot, and around the foot inside and out, and its brim; and make, in the middle of the knob, a quadrangular opening according to the size of the projection in the upper vase, and place in it a thick piece of silver, round, perforated in the same manner. Make likewise a ring separately, which ought to stand between the knob and the vase above, of the same size and kind as that which you had formed under the knob with the ductile iron, and taking a blunted iron you will rub it upon a flat stone, then upon oak-wood, ground charcoal being placed upon it, and with it you will polish the vase inside and out, the knob and foot and the ring, and you will thus rub it with a cloth and chalk finely scraped, until the work be made quite brilliant. These things being thus accomplished, divide the projection of the cup into four, as far as the middle, with a thin file, and turn it over upon a round anvil, so that it may hang equally, and place the ring upon it, and the projection in the opening of the knob, and the small pieces which are from above, and holding these with the left hand firmly and evenly, and in the right the ductile iron, place them in the knob, and cause it to be beaten with the middle-sized hammer until you fasten it firmly. Afterwards melt the silver which you have filed and scraped with that which is left, and strike out a round flat plate with the compass, as large as is the height of the chalice from the foot below to the mouth above, and rather more, and beat it hollow within according to the breadth of the vase at the top, so that it can lie evenly upon it. And, if you wish, draw two circles within,

trahe cum subula obtusa in medio similitudinem agni, sive dexteram quasi de cœlo descendentem et signantem, et litteras inter illos duos circulos, atque cum ferro fossorio subtiliter fode, poliens ad effectum sicut calicem.

CAPUT XXVII.

DE MAJORE CALICE ET INFUSIORIO EJUS.

QUOD si calicem magnum argenteum fabricare volueris, quatuor, aut sex, seu decem marcarum, primo igne purgabis et probabis totum argentum, dehinc divides ordine quo supra. Posthæc accipe duos ferros æquè longos et latos, ad mensuram palmi, et sicut festuca spissos, æqualiter percussos et sanos et ad runcinam diligenter æquatos ; inter quos facies corrigiam ferream æqualiter percussam ac mediocriter spissam, quam complicabis in modum circuli ea amplitudine, ut tibi videatur quod possit impleri illo argento, quod in eo fundere vis. Et cum plicaveris, non conjunges capita, sed modice separabis, ut foramen appareat, per quod infundere possis. Hunc circulum aptabis inter duos ferros æqualiter, ita ut capita ipsius extra ferros parum appareant, et constringes eos tribus curvis ferris fortibus in tribus locis, videlicet inferius et ex utraque parte juxta foramen, sicque linies argillam maceratam circa circulum inter ferros et circa foramen abundanter. Quam formam, cum siccata fuerit, calefacies, et liquefactum argentum infunde. Omne aurum et argentum quod tali modo funditur, nisi contingat ex magna negligentia, semper est sanum ad operandum in eo quodcumque volueris. Circulos autem secundum quantitatem, quam infundere volueris, mensurabis, et facies majores et minores ; fusum vero argentum postquam percusseris ut supra, et vasi formam dederis, imple illud cerâ et percute in ventre, si volueris costas æquales sive rotundas, quæ stent in circuitu sicut cochlearia, quod opus utrumque magnum ornatum dat calici. Quas

with the compass, and portray with a blunted graver the likeness of a lamb in the middle, or a right hand as if descending from heaven and blessing, and letters between these two circles, and hollow it finely with the sculpturing iron, polishing it effectively, as the chalice.

CHAPTER XXVII.

OF THE LARGER CHALICE AND ITS MOULD.

But if you wish to construct a large silver chalice, of four, or six, or ten marks, you will first purify and prove all the silver in the fire; afterwards divide it in the order above. After this take two pieces of iron equally long and wide, of the measure of a palm and thick as a straw, evenly beaten and without flaw, and carefully smoothed with a plane: make between these an iron binding beaten smoothly and moderately thick, which you will bend in fashion of a circle, of such size as it may be apparent to you that it can be filled with the silver which you wish to cast in it. And when you have bent it, do not join the ends together, but you will separate them a little that an opening may appear through which you can pour in. You will adapt this circle equally between the two iron (plates), so that its ends may appear a little beyond the irons, and bind these with three strong iron hooks in three places, namely, below and on each side near the opening, and thus plaster beaten clay around the circle between the irons and abundantly about the opening. When this mould has become dry, you warm it and pour in the melted silver. All gold and silver, which is founded in this manner, is always sound, (unless it happen through great negligence,) for working in it whatever you may wish. You will measure the circles also according to the quantity which you wish to found, and you make larger and smaller: after you have beaten out the melted silver as above, fill it with wax and beat it on the body, if you wish to have ribs flat or round; these stand around like small spoons, both which kinds of work give great ornament to the chalice.

costas si volueris cum nigello parare, hoc procura ut argentum spissius sit, et sic age ut una costa deauretur et altera denigretur, quas semper oportet pares esse. Quas cum percusseris, lima æqualiter et rade, et in illis quas denigrare vis, pertrahe græca folia et fode grosso tractu, camposque eorum fodies gracilibus circulis et subtili opere, deinde compone nigellum hoc modo.

CAPUT XXVIII.

DE NIGELLO.

ACCIPE argentum purum, et æquo pondere divide in duo, addens ei tertiam partem cupri puri. Quas tres partes, cum miseris in fusile vasculum, pondera tantum plumbi, quantum appendit medietas ipsius cupri, quod argento miscuisti, acceptumque sulphur croceum frange minutatim, et mitte plumbum et partem ipsius sulphuris super vasculum cupreum, ac reliquum sulphuris mitte in aliud vas fusile. Cumque liquefeceris argentum cum cupro, move pariter cum carbone, statimque infunde ei plumbum et sulphur ex cupreo vasculo, et rursum commisce cum carbone fortiter, et cum festinatione funde in aliud vas fusile super sulphur quod in eo miseras, moxque deposito vasculo, cum quo fuderas, accipe illud in quod fudisti, et mitte in ignem donec liquefiat, iterumque commovens funde in ferrum infusorium. Quod prius quam frigescat, percute modicum, et calefac parum, rursumque percute, sicque facies donec omnino adtenuetur. Natura enim nigelli talis est, ut si frigidum percutitur, statim frangitur et resilit, nec debet sic calefieri, ut rubescat, quia statim liquescit et fluit in cineres. Adtenuatum vero nigellum mitte in vasculum profundum et spissum, et superfundens aquam, confringe cum malleo rotundo, donec minutissimum

If you wish to ornament which ribs with niello, take heed of this, that the silver be thicker, and so act that one rib may be gilt and the other blackened; it is always necessary that they should be in pairs. When you have beaten out these, file them evenly, and portray Greek foliage in those places which you wish to make black, and carve with a bold stroke, and you sculpture their grounds with graceful circles and with fine work; then compose the niello in this manner.

CHAPTER XXVIII.

OF NIELLO.

Take pure silver, and divide it into two equal weights, adding to it a third part of pure copper. When you have placed these three quantities into a cast metal cup, weigh as much lead as the half of the copper which you have mixed with the silver weighs, and taking yellow sulphur break it very small, and put the lead and part of this sulphur upon a small copper vessel, and place the rest of the sulphur in another cast metal cup. And when you have liquefied the silver with the copper, stir it evenly with charcoal, and instantly pour into it the lead and sulphur from the small copper cup, and again mix it well together with the charcoal, and with quickness pour it into the other molten cup upon the sulphur which you had put into it, and then putting down the small vase with which you have poured out, take that into which you have cast it and place it in the fire until (the contents) liquefy, and again stirring it together pour into the iron crucible. Before this cools beat it a little, and warm it a little, and again beat it, and do thus until it is quite thinned. For the nature of niello is such, that if it is struck while cold it is immediately broken and flies to pieces, nor should it be made so warm as to glow, because it instantly liquefies and flows into the ashes. The niello being made thin, put it into a deep and thick cup, and pouring water upon it, break it up with a

fiat, ejectumque inde sicca, et quod minutum est mitte in pennam anseris atque obstrue, quod vero grossius est, iterum mitte in vas et comminue, rursumque siccatum mitte in alteram pennam.

CAPUT XXIX.

DE IMPONENDO NIGELLO.

CUMQUE sic plures pennas impleveris, accipe gummi, quod vocatur parahas[1], et particulam ejus tere cum aqua in eodem vase ita, ut ex eo vix aqua turbida fiat, et locum quem volueris denigrare cum ipsa aqua fac humidum prius, accipiensque pennam cum levi ferro excute tritum nigellum super eum diligenter donec totum cooperias, sicque per omnia facies. Deinde compone carbones copiosè accensos, et in eos missum vas diligenter cooperi sic, ut super nigellum nullus carbo ponatur, nec cadat. Cumque liquefactum fuerit, tene vas cum forcipe, et verte ex omni parte, quâ fluere videris, et ita convertendo cave ne in terram nigellum cadat. Quod in primo calore non fuerit plenum per omnia, denuo fac humidum, et superpone ut prius, et cave diligenter ne plus opus sit.

CAPUT XXX.

DE FUNDENDIS AURICULIS CALICIS.

SI volueris aures calici apponere, mox ut percusseris et raseris, priusquam operis aliud in eo quid facias, acceptâ cerâ forma inde aures, et sculpe in eis dracones sive bestias aut aves, vel folia quomodocumque modo volueris. In summitate vero utriusque auris pone parum ceræ, rotundæ, sicut

[1] "barabas," *in Cod. Guelph.*

round hammer until it becomes very small, and taking it out, dry it, and put that which is fine into a goose quill and close it up, but that which is coarser place again in the vessel and bruise it, and being again dried, put it into another quill.

CHAPTER XXIX.

OF APPLYING THE NIELLO.

When you have thus filled many quills, take the gum which is called parahas and grind a small piece of it with water in the same vase, so that the water is made scarcely turbid from it, and first moisten the place which you wish to blacken with this water, and taking the quill rub off the ground niello with a light instrument upon it carefully, until you have covered the whole, and do this over the whole. Then gather excessively hot coals, and placing the vase in them, carefully cover them, so that no coal be placed, nor can fall, over the niello. And when it is liquefied, hold the vase with the pincers and turn it from every side on which you see it flow, and in thus turning it round take care that the niello does not fall to the ground. But should it not be completely perfect at the first heating, again moisten it, and superpose (niello) as before, and take great care that no further work is required.

CHAPTER XXX.

OF CASTING THE HANDLES OF THE CHALICE.

Should you wish to apply handles to the chalice, as soon as you have beaten and filed it, before you make any other work upon it, taking wax, form the handles with it, and grave upon them dragons, or animals, or birds, or leaves, in whatever manner you may wish. But on the top of each handle place a little wax, round like a slender candle, half a finger in

gracilis candela longitudine minimi digiti, sed in summitate sit aliquantulum grossior, quæ cera vocatur infusorium; quam solidabis calido ferro. Deinde accipe argillam fortiter maceratam, et co-operi diligenter utrasque aures singillatim, ita ut omnia foramina sculpturæ impleantur. Quæ cum siccatæ fuerint, iterum co-operi per omnia æqualiter, exceptâ summitate infusorii, et tertio similiter facies. Postmodum mitte ipsas formas juxta carbones, ut cum calefactæ fuerint, effundas ceram. Quâ effusâ pones eas omnino in ignem, convertens foramina per quæ cera exiit inferius, et sine donec candescant sicut carbones, statimque liquefac argentum, addens ei modicum de auricalco Hyspanico, ut verbi gratia, si fuerit argenti dimidia marca, pondus duorum nummorum, si vero plus aut minus, e contra; et eiciens formas ab igne siste eas firmiter, et infunde eodem loco, unde ceram effudisti. Cumque refrigerata fuerint, aufer argillam, et cum lima et ferris fossoriis adjunge eas vasi in suis locis, et subjuncturis facies duo foramina longa, unum inferius et aliud superius, quæ foris non appareant, in quibus junges singillatim duos clavos latos, quos facies transire vas per duo foramina ex utraque parte superius et inferius, et configes interius atque solidabis hoc modo.

CAPUT XXXI.

DE SOLIDATURA ARGENTI.

PONDERA duas partes argenti puri, et tertiam cupri rubri, et confunde atque subtiliter lima in vase mundo, et mitte in pennam. Deinde tolle vini petram, quæ crescit interius circa vasa, in quibus optimum vinum diu jacet, et particulas ejus liga in panno, et mitte in ignem ut comburatur tamdiu donec nullus inde fumus procedat. Quo ab igne levato et refrigerato exsuffla cineres panni et illud ustum tere in cupreo vase cum rotundo malleo, admixtâ aquâ et sale ut

length, but let it be somewhat thicker at the top; this wax is called the funnel, and which you will make fast with a hot iron. Then take clay well beaten, and cover carefully both the handles one by one, so that all the hollows of the sculpture may be filled up. When these are dry again cover equally over all, except the top of the funnel, and do thus a third time. Afterwards place these moulds near the coals, that when they have become warm you may pour out the wax. Which being turned out, place them altogether in the fire, turning the openings through which the wax flowed out downwards, and leave them until they glow like the coals, and immediately melt the silver, adding to it a little Spanish brass, as for example, if there be half a marc of silver, the weight of two nummi, but if more or less, accordingly; and taking out the moulds from the fire, support them firmly, and cast into the same place whence you poured out the wax. And when they have become cold remove the clay, and with a file and the chisel join them to the vase in their places, and under the joinings make two long openings, one below and another above, which must not appear from without, in which you join one by one two broad nails, which you make pass through the vase through the two holes, on both sides above and below, and fasten them inside, and solder in this manner.

CHAPTER XXXI.

OF THE SOLDERING OF SILVER.

Weigh two parts of pure silver, and a third (part) of red copper, and mix and finely rasp into a clean vessel, and put this into a quill. Then take wine-stone, which accumulates inside about a vessel in which the best wine has remained for a long time, and tie pieces of it in a cloth and put it into the fire, that it may be burned, until at length no vapour proceeds from it. From which, when taken from the fire and cooled, blow off the ashes of the cloth and grind the burnt (substance) in a copper vessel with a round mallet, water and salt being mixed

sit spissum sicut fex; quod cum ligno tenui linies circa clavos interius et exterius, et excuties cum brevi ferro limatum argentum desuper, sicque siccabis. Iterum linies mixturam illam desuper spissius quam ante, et mittes in ignem, adhibitisque carbonibus, diligenter cooperies, leniterque sufflabis longo flatu, donec solidatura liquefiat sufficienter; eductumque vas ab igne et modice refrigeratum lavabis, et si firmi sunt clavi bene; sin autem, rursum fac eis, sicut prius. Cumque firmi fuerint, elima eos interius et rade æqualiter, ut nullus considerare queat in quo loco steterint, appositasque exterius auriculas rursum diligenter adjunge. Deinde fac per medium auricularum contra clavos subtilia foramina, et in eodem loco ultra clavos similiter, in quibus eos configes omni opere consummato, sic ut nemo percipiat qualiter adhæreant. Post hæc sculpe et fode ipsas auriculas studiose cum limis et ferramentis, et si quid volueris in eis denigrare, hoc modo facies.

CAPUT XXXII.

ITEM DE IMPONENDO NIGELLO.

CUM miscureis et[1] fuderis nigellum, partem unam inde tolles et percuties quadrangulam, longam et gracilem. Deinde accipe auriculam cum forcipe, et calefac in igne donec rubescat, et cum altero forcipe longo et gracili tene nigellum et frica super omnia loca, quæ denigrare volueris, donec tractus omnes pleni sint; ablatumque ab igne cum lima æquali diligenter plana, donec argentum sic appareat, ut vix tractus considerare possis, et sic cum rasorio ferro lima, rugas diligenter erade, et quod reliquum est deaurabis. Quod deauratum hoc modo compones.

[1] *Vitiosè* "foderis" *in hoc Manuscr.*

with it until it is as thick as lees; with a thin piece of wood you anoint about the nails inside and outside, and you rub off with a small iron the filed silver over it, and you will thus dry it. Again paint this mixture over it more thickly than before, and put it into the fire, and coals being applied, carefully cover it, and you will blow gently with a long breath until the soldering is sufficiently melted; withdrawing the vase from the fire, and cooling it slightly, you will wash it, and, if the nails are firm, it is well; but if not, do again to them as before. And when they have become firm, file them off inside and scrape them smoothly, that no one may be able to see in what place they have stood, and the handles being set on outside, again carefully join them on. Then make through the middle of the handles against the nails very fine hollows, and likewise in the same place beyond the nails, into which you fix them with all perfected labour, so that no one may perceive how they adhere. After these things sculpture and grave these handles studiously with files and iron instruments, and if you wish to blacken anything in them, act in this manner.

CHAPTER XXXII.

ALSO OF LAYING ON THE NIELLO.

When you have mixed and melted the niello, take a portion of it and beat it square, long and slender. Then take the handle with the pincers and heat it in the fire until it glows, and with another forceps, long and thin, hold the niello and rub it over all the places which you wish to make black until all the drawings are full, and carrying it away from the fire carefully make it smooth with a flat file until the silver appear, so that you can scarcely observe the traits, and so scrape it with the cutting iron, carefully cut away the inequalities, and you will gild what remains. Which gilding you compose in this manner.

CAPUT XXXIII.

DE COQUENDO AURO.

TOLLE aurum qualecunque sit, et percute donec tenues laminæ fiant, latitudine trium digitorum et longitudine quantum possis. Deinde incide partes ut æque longæ et latæ sint, et conjunge eas pariter atque perfora per omnia cum rasorio ferro tenui. Postea accipe duas testas ollæ igne probatas tantæ magnitudinis ut aurum in eis possit jacere, et frange tegulam minutatim, sive argillam fornacis arsam et rubicundam, comminutam pondera in duas partes æquales, et adde ei tertiam partem salis eodem pondere, quæ modice aspersa cum urina commisceatur ita, ut non adhæreant sibi, sed vix madida sint, et mitte inde parum super unam testam juxta latitudinem auri, deinde ipsius auri unam partem, rursumque confectionem, et iterum aurum quod semper confectione ita cooperiatur, ne aurum auro tangatur, sicque imple testam usque ad summum, et desuper cooperi cum altera testa, quas diligenter circumlinies argillâ mixtâ et maceratâ, ponesque ad ignem, ut siccetur. Interim compone furnum ex lapidibus et argillâ, altitudine duorum pedum, et latitudine pedis et dimidii, inferius latum, superius vero strictum, ubi foramen sit in medio, in quo eminebunt tres lapides longiores et duri, qui possint flammam diu sustinere, super quos pones testas cum auro, et cooperies aliis testis abundanter. Deinde suppone ignem et ligna, et cave ne deficiat ignis copiosus per spatium diei ac noctis. Mane vero eiciens aurum, rursum funde, percute et impone furno sicut prius. Iterum autem post diem noctem aufer, et admiscens ei modicum cupri, funde sicut prius, et repone super furnum. Cumque tertio deposueris, lava diligenter et sicca; sicque ponderans vide quantum desit, deinde complica et serva.

CHAPTER XXXIII.

OF HEATING THE GOLD.

Take gold, of whatsoever sort it may be, and beat it until thin leaves are made in breadth three fingers, and as long as you can. Then cut out pieces that are equally long and wide, and join them together equally, and perforate through all with a fine cutting iron. Afterwards take two earthen pots proved in the fire, of such a size that the gold can lie flat in them, and break a tile very small, or clay of the furnace burned and red, weigh it, powdered, into two equal parts, and add to it a third part salt for the same weight; which things being slightly sprinkled with urine, are mixed together so that they may not adhere together, but are scarcely wetted, and put a little of it upon a pot about the breadth of the gold, then a piece of the gold itself, and again the composition, and again the gold, which in the digestion is thus always covered, that gold may not be in contact with gold; and thus fill the pot to the top, and cover it above with another pot, which you carefully lute round with clay, mixed and beaten, and you place it over the fire, that it may be dried. In the mean time compose a furnace from stones and clay, two feet in height, and a foot and a half in breadth, wide at the bottom, but narrow at the top, where there is an opening in the middle, in which project three long and hard stones, which may be able to sustain the flame for a long time, upon which you place the pots with the gold, and cover them with other tiles in abundance. Then supply fire and wood, and take care that a copious fire is not wanting for the space of a day and night. In the morning, taking out the gold, again melt, beat and place it in the furnace as before. Again also, after a day and night, take it away, and mixing a little copper with it, melt it as before, and replace it upon the furnace. And when you have taken it away a third time, wash and dry it carefully, and so weighing it, see how much is wanting, then fold it up and keep it.

CAPUT XXXIV.

ITEM UNDE SUPRA.

SI vero parum fuerit auri, quod coquere vis, ipsum percute, et compone in testas sicut superius. Postea accipe ollam novam et frange in fundo unum foramen, et circa latus quatuor, et fac in argilla breve vasculum cum tribus pedibus sic ab invicem separatis, ut possint stare super foramen, quod est in fundo ollæ; super quod cum siccatum fuerit pones testas cum auro, et elevabis ollam super tres lapides a se aliquantulum remotos æquè spissos, et inmitte carbones ardentes, deinde extinctos, sicque quotiens defecerint superpone frigidos, et nunquam patieris testas nudas esse ab igne. Interdum vero cum gracili ligno per [1] foramen inmisso move carbones, et inferius similiter, ut cineres exeant et ventus aditus habeat Sicque facies cum carbonibus in olla, sicut superius cum lignis in furno.

CAPUT XXXV.

DE MOLENDO AURO.

COCTUM vero pleniter aurum, si molere volueris, mitte inde super testam octo [2] denariorum et pondera octies tantum vivi argenti, cui statim inmitte aurum et frica donec album fiat, atque particulatim confringe. Tolle quoque unum vasculum ex his, in quibus aurum vel argentum funditur, quod tamen ad istud opus spissius illis debet esse, et mitte in ignem donec candescat; ferrum etiam gracile et curvum, in uno capite manubrio infixum, in altero vero habens nodum rotundum, mitte similiter in ignem, et cum utrumque canduerit, tene forcipe vasculum super scutellam latam, siccam, et funde

[1] "foramina," *imò.*

[2] "nummorum." *Cod. Guelph.*

CHAPTER XXXIV.

THE SAME AS ABOVE.

But if there should be but little gold, which you wish to digest, beat it and lay it together in the pots as before. Afterwards take a new clay pot and break a hole in the bottom, and four (holes) round the sides, and make a small vase in clay, with three feet so separated from each other that they can stand over the opening which is in the bottom of the pot; place the vessels with the gold upon this when it has become dry, and you will elevate the pot upon three stones somewhat apart from each other, and equally thick, and put in some glowing coals, then some dead (coals), and thus as often as they are deficient superpose fresh, and never suffer the vessels to be destitute of fire. But sometimes stir the coals with a small piece of wood put through the opening, and the like below, that the ashes may come out and the air may have access. And act with the coals in the earthen pot as with the wood in the furnace above.

CHAPTER XXXV.

OF GRINDING THE GOLD.

The gold being fully prepared, if you wish to grind it, put eight denarii[1] into a pot, and weigh eight times as much quicksilver, into which you will immediately put the gold, and rub it until it is made white, and break them together very finely. Take also a small vase from those in which gold or silver is melted, which, however, should be thicker than those for this work, and place it in the fire until it glows; put likewise in the fire a thin and curved iron, fixed into a handle at one extremity, but at the other having a round knob, and when both have become glowing, hold the small vase with the forceps over a basin wide and dry, and pour the quick-

[1] An ounce Troy; a denarius being about equivalent to a dram Troy, *or a seventh of the Roman ounce.*

in illud vivum argentum cum auro, et festinanter cum ferro curvo et candente frica illud et mole, donec nihil sentias in vasculo, nisi humorem; moxque effunde in aquam. Ejectâ vero aquâ illâ, mitte aurum in manum sinistram, et lava diligenter, probans digito, si bene molitum sit; et si est, pone super pannum lineum mundum, et jacta hac et illac, donec siccetur aqua.

CAPUT XXXVI.

ITEM ALIO MODO.

QUOD si natura auri talis est, ut sic non possis molere, accipe lapidem æqualem, et in medio ejus fac foramen latitudine trium digitorum et simili profunditate. Deinde para tibi lapidem duriorem illo, sic gracilem, ut possit in illo foramine converti, et sic longum, ut possit in lignum figi et firmari, quod lignum sit longitudine trium ulnarum, et, in inferiori parte, in qua lapis jungendus est, sit grossitudine unius tybiæ. Super quem lapidem, altitudine dimidii pedis, transforetur ipsum lignum, cui jungatur aliud lignum tenue latitudine duarum palmarum, in quo cauda fiat, quæ foramen longi ligni pertranseat, superquod tenue lignum ligetur lapis magnitudine unius pedis, a quo lapide fiat sursum lignum gracile et rotunde incisum atque planum, ita ut inter manus possit volvi. His ita compositis pone majorem lapidem in pelvim, sive in vas ligneum æquale, et vide ut lapis firmiter jaceat, et vas firmiter stet. Cumque aurum cum vivo argento in foramen ejus miseris, et sabulum desuper atque aquam, impone lapidem minorem, qui ligno junctus est, tenensque in superiori parte ipsum lignum, converte modicum inter manus tuas, et mox per impulsum illius lapidis, qui ligatus est inferius, circumferetur, sicque circumferendo mole per quatuor vel tres horas. Interdum vero respice et proba digito, et rursum in-

silver with the gold into it, and with quickness rub and grind it with the curved and glowing iron, until you feel in the vase nothing but a liquid, and directly pour it into water. This water being thrown away, put the gold into the left hand, and wash it carefully, proving with the finger if it be well ground, and if it is, place it upon a clean linen cloth, and cast it here and there until the water be dried away.

CHAPTER XXXVI.

THE SAME, IN ANOTHER MANNER.

But if the nature of the gold is such that you cannot thus grind it, take a smooth stone, and make a hollow three fingers in breadth, and of a like depth. Then fashion for yourself a harder stone than it, small, so that it can be turned round in this hollow, and long, so that it can be fixed and made firm in wood, which wood must be three yards in length, and in the lower part, to which the stone is to be joined, it must be of the thickness of a flute. Above this stone, at the height of half a foot, this wood is pierced through, and to which another thin piece of wood, two palms in breadth, in which a projection is made, which may pass through the perforation of the long piece of wood, upon which thin wood a stone is tied, of the size of a foot, from which stone upwards the wood is made thin and cut round and smooth, so that it can be turned round between the hands. These things being thus arranged, place the larger stone in a basin, or a flat wooden vase, and see that the stone lie firmly and that the vase is firmly placed. And when you have placed the gold with the quicksilver in the hollow, and sand and water above it, put on the smaller stone which is joined to the wood, and holding this wood in the upper part, turn it round a little between your hands, and soon, through the impulse of that stone which is fixed on below, it is carried round, and thus, by the rotation, grind for four or three hours. Sometimes, however, examine it and prove it with the finger,

mitte sabulum cum aqua. Cumque girando et regirando ipsum sabulum cœperit ebullire et per lapidem diffundi, cum ligno gracili longo et tenue recollige semper et in foramen repone, ne forte aurum cum sabulo egeratur et non molatur. Quod cum pleniter molitum fuerit, eiciatur et lavetur et siccetur ut supra, ponaturque super libram. Si vero quicquam defuerit, laventur sordes qui fluunt de lapide, et sic invenitur, quia idcirco idem lapis in vase ponitur. Hoc modo etiam argentum purum tenuissime percussum et vivo argento mixtum moli debet, quia in calido vasculo cum calido ferro moli non valet. Sic autem commisceatur ut vivi argenti sint quinque pondera, et sextum sit argentum purum.

CAPUT XXXVII.

ITEM UNDE SUPRA.

POTES etiam aurum levius molere hoc modo. Accipe testam ollæ capacem igne probatam, et pone in carbones donec omnino candescat, et mitte in eam aurum vivo argento mixtum ac minutatim confractum, tenensque cum forcipe vibra manum æqualiter, et mox videbis quomodo liquefiat aurum et commisceatur vivo argento. Cumque omnino liquidum fuerit, mox funde in aquam atque lava et sicca ut supra. Hoc omnino cave, ne jejunus molas aut deaures, quia fœtor vivi argenti magnum periculum est jejuno stomacho et infirmitates diversas generat, contra quas uti debes zituar[1] et bacas lauri, pipere et allio atque vino. Posthæc appende ipsam deauraturam in statera, et divide in duo, et medietatem ejus rursum in duo, donec invenias singulos denarios, et mitte eos sigillatim in pennas anseris, ut scias quantum unicuique loco deaurando superponas. Deinde percute partem cupri rubri in similitudinem fossorii ferri et infige manubrio, summitatemque

[1] "Ziduar," *Cod. Guelph.*

and again put in sand with water. When from the rotation and re-rotation the sand has begun to bubble and be diffused over the stone, collect it again always, and replace it in the hollow with a small, long, and thin wood, unless by chance the gold should be scattered and not milled. But when it is completely ground it is taken out and washed and dried as above, and it is placed upon a scale. If, however, any should be deficient, the dregs which flow from the stone are washed, and it is thus found; for this reason it is that the stone is placed in the vase. In this manner also should pure silver, very thinly beaten, and mixed with quicksilver, be milled, because it cannot be milled in the hot vessel with a heated iron. It should be so mixed together, however, that five parts, by weight, may be of quicksilver, and the sixth be pure silver.

CHAPTER XXXVII.

THE SAME AS ABOVE.

You can also grind gold lighter in this manner. Take a large vase of clay proved in the fire, and place it in the coals until it quite glows; and put into it the gold mixed with the quicksilver and broken up very small, and holding it with the pincers, move round the hand evenly, and you will soon see how the gold is liquefied and mixed with the quicksilver. And when it has become quite liquid, directly pour it into water, and wash and dry it as above. Beware above all of this, that you do not grind, or gild, fasting, because the exhalation of quicksilver is of great danger to a fasting stomach, and it generates different infirmities, against which you should use Zedoar and the berries of the laurel, with pepper and garlick and wine. After this, weigh this gilding substance in the balance and divide it in two, and the half of it again into two, and until you obtain single drams, and put them singly into goose-quills, that you may know how much you may lay on in gilding in every place. Then beat a portion of red copper into the shape of a chisel, and fix it to a handle, and

ejus lima et rade rotundam et aliquantum tenuem, quam fricabis vivo argento donec alba fiat, ut inde possis deaurare. Postea facies confectionem ad invivandum opus deaurandum que hoc modo.

CAPUT XXXVIII.

DE INVIVANDIS ET DEAURANDIS AURICULIS.

SUME vini lapidem, de quo supra diximus, et tere diligenter super lapidem siccum, addesque ei tertiam partem salis, et mitte in testam ollæ capacem, infundens que ei aquam illam, in quam projecisti aurum noviter molitum, atque imponens modicum vivi argenti, mitte super carbones donec calidum fiat, et cum ligno commove. Habeas etiam setas porci grossitudine trium digitorum aut quatuor, ferro colligatas in medio, duas partes mundas, cum quibus lavabis aurum et argentum, et duas cum quibus deaurabis, unam siccam alteram humidam. His omnibus hoc ordine compositis, accipe auriculas argenteas ad manus, et panniculum lineum complicatum tinge in confectionem calidam, cum quo fricabis omnia loca, quæ deaurare volueris in eis. Cumque invivare volueris, calefac eas super carbones et cum setis ipsa confectione humidis frica illas fortiter, donec omnes fossuræ vivo argento fiant albæ, interdum calefaciendo et interdum fricando, et ubi cum setis non potueris pertingere, cum cupro deauratorio et ligno gracili fricabis, faciens hoc super scultellam deauratoriam ligneam, quæ sit ad modicum opus tornatilis, capax, et ad magnum quadra, cava et æqualis. Deinde super ipsam scultellam incide deauraturam minutatim cum cultello, et cum cupro deauratorio pone diligenter per omnia, et humidis setis æqua, atque cum forcipe longo et gracili in anteriori parte duobus panniculis involuto levabis, et pones super carbones donec calefiat, et setis

file and scrape its end round and somewhat thin; you will rub it with quicksilver until it is made white, that you may be able to gild with it. Afterwards make the composition for reviving and gilding in this manner.

CHAPTER XXXVIII.

OF REVIVING AND GILDING THE HANDLES.

Take the wine-stone, of which we have before spoken, and grind it carefully upon a dry stone, and add to it a third part salt, and put it into a large vase of clay, and pouring upon it that water into which you have thrown the recently milled gold, and putting to it a little quicksilver, place it upon the coals until it is made hot, and stir it with wood. Have also (a brush of) hog's bristles of the thickness of three or four fingers, bound together with iron in the middle; you clean both ends, with which you will wash the gold and silver, and (have) two with which you will gild, one dry, the other wet. These things arranged in this order, take the silver handles in your hand, and dip a small linen cloth, folded, into the hot preparation, with which you will rub all the places which you may wish to gild in them. And when you wish to revive them, warm them over the coals, and with the brushes moistened with the same preparation, rub them strongly, until all the hollows are made white with the quicksilver, sometimes warming and sometimes rubbing; and where you cannot reach with the brushes, you will rub with the brass gilder and the slender wood, doing this over a wooden gilding dish, which may be turned for a small work, and capacious and square and hollow and flat for a large work. Then over this dish cut the gilding (preparation) very small with a knife, and lay it carefully over all with the copper gilder, and smooth it with the moistened brushes; and with the long and thin tongs, enveloped at the extremity by two small pieces of linen, you will raise it, and place it over the coals until it is made hot, and you will again smooth it with the brushes, and

rursum æquabis, sicque tamdiu facies usque dum aurum per omnia adhæreat. Secundò incide aurum et cum cupro superpone, atque cum igne et setis fac sicut superius. Tertio vero similiter facies. Cumque tertia vice aurum cœperit siccari, cum siccis setis fricabis, donec incipiat pallescere. Si vero ex negligentia contigerit, ut aliqua macula appareat in argento, ubi aurum tenue sit et inæqualiter positum, cum cupro superpone, et cum siccis setis æqua, donec per omnia æquale sit. Quod cum videris, mitte in aquam et mundis setis lava, rursumque ponens super carbones tamdiu calefac, donec omnino croceum fiat.

CAPUT XXXIX.

DE POLIENDA AURATURA.

TOLLE fila ex auricalco gracilia complicans ea, ita, ut plicaturæ sint ad longitudinem digiti; et cum quadruplices fuerint, colliga eos filo lineo, ut sit quasi una pars. Ex his partibus fac quatuor aut quinque, vel sex, ita ut una pars habeat tres plicaturas, alia quatuor, tertia quinque, et sic ascendendo usque ad octo. Quibus omnibus singillatim colligatis, fac modicum foramen in ligno, in quod pones ex his particulis unam, et infunde plumbum, ita ut cum frigidum fuerit et extraxeris, adhæreant sibi ipsæ plicaturæ quasi plumbeo nodo infixæ. Hoc modo fac singulis partibus singulos nodos plumbeos, et incidens plicaturas omnes jam in altera parte, lima et rade summitates earum, ut rotundæ fiant et æquales; cum quibus quasi sculpendo, polieris, polies auriculas deauratas in aqua pura et vase munda. Quas cum extremi parte sculpendo polieris, pone super carbones donec calefactæ in fulvum colorem convertantur, et perdant claritatem, quam

you will do this until the gold adhere everywhere. Cut the gold a second time, and superpose it with the copper instrument, and do as above with the fire and brushes. And a third time you do likewise. And when for the third time the gold has commenced to dry, you will rub it with the dry brushes until it begins to grow pale. If, however, it should happen through negligence that any blemish appear upon the silver, where the gold may be placed thinly and unequally, superpose it with the copper instrument, and spread it with the dry brushes until it is even everywhere. When you see which, place it in water, and wash it with the clean brushes, and again placing it over the coals, warm it until it become altogether yellow.

CHAPTER XXXIX.

OF POLISHING THE GILDING.

Take fine brass wire, bending it so that the folds may be the length of a finger; and when they have been four times folded, bind them with a flaxen thread so that they may be as one. Of these parcels make four, or five, or six, so that one kind may have three, another four, a third five, and so increasing unto eight. All these being separately tied up, make a small hole in a piece of wood, in which you place one of these small bundles, and pour in lead, so that when it has become cold, and you have taken it out, these folds may adhere together as if fixed in a leaden knob. In this manner make with each parcel separate leaden knobs, and now cutting all the ligatures at the other end, file and scrape their tops, that they may become round and smooth; when with these, as if carving them, you have polished them, you polish the gilt handles in pure water and in a clean vessel. When, by rubbing, you have polished these in the uttermost part, you place them upon the coals, until, being made warm, they are changed into a yellow colour, and lose the brightness which

poliendo acceperant, extinctasque in aqua rursum diligenter sculpendo polies, donec eximium fulgorem accipiant, sicque colorabis eas, tali confectione.

CAPUT XL.

DE COLORANDO AURO.

SUME attramentum, mitte in testam ollæ mundam et igne probatam, ponens super carbones, donec omnino liquefiat et indurescat. Deinde aufer a testa et mitte sub ipsos carbones, atque cooperi diligenter, et cum folle suffla, donec comburatur et in rubeum colorem convertatur. Statim ablatum ab igne cum refrigeratum fuerit, tere in scutella lignea cum ferreo malleo, addens ei tertiam partem salis, temperansque cum vino sive urina, rursum fortiter tere, donec spissum fiat sicut fex. Ex hac confectione cum penna cooperi quod deauratum est, sic ut nihil auri appareat, et pone super carbones, donec exsiccetur, et fumus ex omni parte modicum procedat, et mox auferens ab igne mitte in aquam, lavans diligenter cum setis mundis, rursumque exsiccans super carbones, involve panno mundo donec refrigeretur.

CAPUT XLI.

DE POLIENDO NIGELLO.

TENENS vero illud in eodem panno, rade diligenter omnia loca, quæ nigello denigrata sunt, cum ferro rasorio.

Post hæc habeas ([1]lapidem) nigrum et mollem, qui leviter possit incidi et pene cum ungue radi, et cum illo fricabis

[1] "lapidem," *non apparet in codice Harleo; hoc surrogatur ex Cod. Guelpherbytano.*

they have taken in polishing: quenched in water you again carefully, as if carving, polish them until they receive a most brilliant lustre, and you will thus colour them with this composition.

CHAPTER XL.

OF COLOURING GOLD.

Take atramentum; put it in an earthen vessel, clean, and proved in the fire, placing it over the coals until it has become liquefied and grows hard. Then take it from the vase, and place it under the same coals, and cover it carefully, and blow with the bellows until it is calcined and changed into a red colour. Immediately carrying it from the fire, when it has become cold, grind it in a wooden cup with an iron pestle, adding to it a third part salt, and tempering it with wine or urine, again grind it strongly until it is made as thick as lees. With a pen cover the gilding with this composition so that no gold appear, and place it over the coals until it is dried, and a slight vapour comes from it everywhere, and immediately taking it away from the fire place it in water, washing it carefully with clean bristles; and again drying it over the coal, wrap it in a clean cloth until it grows cold.

CHAPTER XLI.

OF POLISHING NIELLO.

Holding it in the same cloth, scrape all the parts carefully which are blackened with the niello, with the cutting instrument.

Afterwards you have a black and soft stone, which can easily be cut and almost be scraped with the nail, and with it

nigellum cum saliva madefactum diligenter ac æqualiter per omnia, donec tractus omnes aperte videantur et omnino æquum sit. Habeas etiam lignum de arbore tilia, grossitudine et longitudine minimi digiti, siccum et æqualiter incisum; super quod pones pulverem illum humidum, qui procedit de lapide et saliva in fricando, et cum ipso ligno ac eodem pulvere diutissime fricabis nigellum, et leviter semperque adde salivam ut humidum sit, donec lucidum fiat per omnia. Deinde tolle sepum de foramine auricula tuæ, et cum exterseris nigellum lineo panno subtili, per omnia linies, et cum corio hyrcino, sive cervino leniter fricabis, donec omnino clarum fiat.

CAPUT XLII.

DE ORNATU VASIS CALICIS.

TALI modo auriculis pleniter perfectis, accipe vas calicis, cujus costas superius denigrasti dimidias, et illas, quas inter has absque nigello reliquisti, lima æqualiter et rade, ac pertrahe in eis opus quodcunque volueris, sic tamen ut aliquantulum discrepet ab omni opere nigelli, atque cum fossorio ferro gracili subtiliter fode. Post hæc deaurabis eas, totumque vas interius et exterius excepto nigello, et polies atque colorabis sicut auriculas. Deinde cooperies et circumligabis rotundam incudem cum pergameno æquali, super quam pones vas, quod teneat puer ante te sedens utrisque manibus, coaptans unamquamque costam incudi æqualiter, secundum quod ei jusseris. Interim tolle ferrum gracile, quod foramen habet in cuspide, cujus percussurâ subtilissimum circulum fac, et cum illo implebis omnes campos in deauratis costis, desuper cum malleo leniter percutiendo, et opere punctorio unumquemque circulum alteri ordinatim conjungendo. Quo expleto mitte vas super carbones, donec illæ percussuræ in-

you rub the niello, wetted with saliva, carefully and smoothly everywhere, until all the drawings are plainly seen, and it is quite smooth. You also have a piece of wood from the lime tree, of the length and thickness of the smallest finger, dry and smoothly cut; upon which you place this wet powder, which comes from the stone and saliva in rubbing, and with this wood and the same powder you rub the niello a long time, and lightly, and always add saliva, that it may be wet, until it is made brilliant everywhere. Then take wax from the hollow of your ear, and when you have wiped the niello clean with a fine linen cloth, you anoint it everywhere, and with goat or hart's skin you will lightly rub it until it is made quite bright.

CHAPTER XLII.

OF ORNAMENTING THE CUP OF THE CHALICE.

The handles being completely finished in this manner, take the cup of the chalice, the ribs of which you have already blackened one half, and file and scrape those parts which you have alternatively left without niello, and portray upon them whatever work you wish, so, however, that it may somewhat differ from all the niello work, and with a slender sculping iron you will carve it very finely. You will afterwards gild them, and all the vase inside and outside, the niello excepted, and you will polish and colour them like the handles. Then you cover a round anvil, and you will bind it round with smooth parchment, over which you place the cup, which the boy sitting before you can hold with both hands, adjusting each rib to the anvil evenly, according to what you may order him. In the mean time take a fine instrument which has a hole at the point, by the blow of which you produce a very fine circle, and you will fill up all the grounds in the gilt ribs with it, striking lightly upon it with a hammer, and joining successively each circle to the other with punched work. This being accomplished, place the cup over the coals until these strokes receive a yellow colour in-

terius fulvum colorem recipiant, nigellum autem limabis et polies sicut superius. Deinde conjunge auriculas unamquamque in suo loco, et trans foramina, quæ in eis sunt, confige eas aureis clavis cum gracili malleo ferro desuper feriendo, et altero ferro subposito donec firmiter stent, et rade diligenter atque poli cum obtuso ferro ipsas percussuras, ut nemo percipere possit, qualiter adhæreant.

CAPUT XLIII.

DE PEDE CALICIS.

POST hæc sume quartam partem argenti, addens ei quicquid a vase limasti et rasisti; et funde ordine quo supra; unde facies pedem cum nodo sicut pedem minoris calicis, excepto quod in hoc majori formabis costas a latitudine pedis inferius ascendentes usque ad nodum, quas dimidias denigrabis, et alias fodies et deaurabis atque modis omnibus decorabis sicut in vase. Quo perfecto anulum quoque, qui ponendus est inter vas et nodum, deaurabis atque conjunges, et configes sicut minorem calicem.

CAPUT XLIV.

DE PATENA.

DEINDE quicquid residui fuerit argenti, funde: unde facies patenam. Quam cum attenuaveris, fac in medio ejus circulum secundum latitudinem calicis, et infra hunc circulum metire octo spatia æqualiter divisa, et in unoquoque spatio fac circulum dimidium, ut sint quasi octo arcus, quos cum rotundo malleo percuties donec cavi fiant, et inferius ductili opere percuties angulos inter ipsos arcus, et limbum circa eos latitudine minoris ungulæ, qui super emineat

side; you will likewise file and polish the niello as above. Then join on the handles, each in its place, and through the holes which are in them fasten them with golden nails, striking upon them with a slender iron hammer, and with another iron placed under until they stand firmly, and scrape and polish these beaten places carefully, that no one may perceive how they are joined.

CHAPTER XLIII.

OF THE FOOT OF THE CHALICE.

After this take a fourth part of the silver, adding to it whatever you have filed and scraped, and melt it as above; with it you make the foot with its knob like the foot of the smaller chalice, excepting that in this larger one you will make the ribs ascending from the broad part of the foot below up to the knob, the half of which you will blacken, and you carve and will gild the others, and will decorate them in all manners as the cup. Which being finished, you will gild and join on the ring, which is to be placed between the cup and the knob, and you fasten it as upon the smaller chalice.

CHAPTER XLIV.

OF THE PATENA.

Then melt whatever should remain of the silver. When you have thinned this, make a circle in the middle of it, according to the breadth of the chalice, and below this circle measure out eight spaces equally divided, and in each space make half a circle, that there may be as if eight bows, which you beat with a round hammer until they become hollow, and below you hammer angles between these bows in ductile work, also a border round them of the width of the little nail, which may

æqualitatem totius patenæ; quem fodies subtiliter et denigrabis, reliquamque patenam deaurabis, et polies utrumque sicut superius.

CAPUT XLV.

DE FISTULA.

FISTULUM quoque facies in calice hoc modo. Fac tibi ferrum longitudine palmæ unius et quatuor digitorum, quod in una summitate valde sit gracile, et inde procedat grossius usque ad alteram summitatem, quæ sit sicut festuca; sitque ferrum rotundum et æqualiter limatum. Cumque attenuaveris argentum purum, complica illud circa hoc ferrum, conjungens summitates æqualiter cum lima, ejectoque ferro mitte in ignem et solida. Rursum imposito ferro percute cum malleo æqualiter per omnia tamdiu, donec junctura non appareat. Deinde fac nodum singulariter rotundum et cavum, sive quadrangulum et solidum, et fac in eo foramem, per quod immittatur fistula ab inferiori parte, usque pene ad summum, sicque ejecto ferro rursum solidabis per omnia. Cumque firmum fuerit, denuo imposito ferro percuties undique a nodo deorsum donec æqualis fiat et rigida, et a nodo sursum silicet ea parte, quæ latior et grossior est, impone ferrum tenue, et latum secundum amplitudinem fistulæ, atque cum malleo percute super incudem, ita ut foramen superius sit quadrum et tenue, quod a nodo sursum super calicem eminere debet, et ore teneri, inferius vero rotundum et gracile. Quo facto, si volueris, nodum cum nigello variare poteris, et reliquam fistulam ordine quo supra deaurabis. Hoc omnino cave, ut omne argentum spissum quod deaurare volueris, sive in scypho, vel scutellâ aut ampullâ, fortiter radas, quia in percutiendo ab igne et malleo cutem ex se trahit, quæ si abrasa non fuerit,

rise above the flat part of the whole patena; you sculp this finely and cover it with niello, and you will gild the rest of the patena, and you polish it on both sides as above.

CHAPTER XLV.

OF THE PIPE.

You make also the pipe for the chalice in this manner. Make an iron in length a palm and four fingers, which at one end must be very fine and must continue increasing to the other extremity, which must be like a straw; and let the iron be round and smoothly filed. And when you have thinned some pure silver, fold it round this iron, joining the ends smoothly with a file, and taking off the iron, place it in the fire, and solder it. Again placing the iron in it, beat it with the hammer equally over all until the join is no longer visible. Then make, by itself, a knob round and hollow, or square and solid, and make a perforation in it, through which the pipe is placed from the lower part almost to the top, and thus, the iron being taken away, you will again solder everywhere. And when it has become firm, the iron being put on anew, you beat everywhere from the knob downwards until it is made smooth and firm; and from the knob upwards, namely, in that part which is wider and thicker, place on an iron, thin and wide, according to the size of the pipe, and beat it with the hammer upon an anvil, so that the upper opening may be square and thin, which from the knob upwards should surmount the chalice and be held in the mouth, but be below round and slender. Which being done, if you wish, you can ornament the knob with niello, and you will gild the rest of the pipe in the fashion above. Take great care in this, that you strongly scrape all thick silver which you wish to gild, whether for a cup, or plate, or bottle, because in working it forms a pellicle' outside, from the fire and hammer, which, if not scraped away when it is gilt, when it is coloured

cum deauratur et super ignem frequenter et diu coloratur, elevantur per loca subtiles vesicæ, quæ cum franguntur apparet argentum, et opus deturpatur, nec potest emendari nisi deauratura omnino eradatur, et denuò deauretur.

CAPUT XLVI.

DE AURO TERRÆ EVILATH[1].

AURI multa sunt genera, ex quibus præcipuum nascitur in terra Evilath, quam Phison[2] fluvius circuit secundum Genesim. Cujus venas, cum sub terra invenerint viri hujus artis periti, effodiunt, et igne purificatum atque camino probatum in usus suos redigunt.

CAPUT XLVII.

DE AURO ARABICO.

EST et aurum Arabicum pretiosissimum et eximii ruboris, cujus usus in antiquissimis vasis frequenter reperitur, cujus speciem moderni operarii mixtiuntur[3], dum pallido auro quintam partem rubei cupri addunt, et multos incautos decipiunt. Quod hoc modo caveri potest, ut mittatur in ignem, et si purum est aurum, non amittit fulgorem, si vero mixtum, omnino mutat colorem.

[1] "Evilat," *in Cod. Guelph.*
[2] "Gyon," *in Cod. Guelph, malè apparet.*
[3] *imò,* "misceuntur."

over the fire frequently and for a long time, becomes raised in places as small blisters, whose fracture shows the silver, and the work is deteriorated, nor can it be mended unless the gilding be wholly scraped off, and it be again gilt.

CHAPTER XLVI.

OF THE GOLD OF THE LAND OF HEVILATH.

There are many kinds of gold, among which the best kind is produced in the land of Hevilath, which, according to Genesis, the river Phison[1] surrounds. The veins of which, when men, skilful in this art, have discovered them underground, they dig up, and, purified by fire and proved in the furnace, they subject it for their use.

CHAPTER XLVII.

OF ARABIAN GOLD.

Arabian gold is also very precious and of a beautiful red, the employment of which in very ancient vases is frequently found, which kind modern workmen are compounding when they add to a pale gold a fifth part of red copper, and they deceive many unwary persons. This can be guarded against in this manner: let it be placed in the fire, and if it is pure gold it does not lose its brightness; if, however, it is mixed, it quite changes colour.

[1] In the Wolfenbüttel MS. the river Gyon is by error placed for the Phison, which "compasseth the whole land of Havilah." Gen. ii. 7.

CAPUT XLVIII.

DE AURO HYSPANICO.

EST etiam aurum, quod dicitur Hyspanicum, quod conficitur ex rubeo cupro et pulvere basilisci et sanguine humano atque aceto. Gentiles enim, quorum peritia in hac arte probabilis est, creant sibi basiliscos hoc modo. Habent sub terra domum superius et inferius ex omni parte lapideam cum duabus fenestellulis, tam brevibus, ut vix aliquid luminis per eas appareat; in quam ponunt duos gallos veteres duodecim aut quindecim annorum, et dant eis cibum sufficientem. Qui cum incrassati fuerint, ex calore pinguedinis conveniunt inter se et ponunt ova. Quibus positis eiciuntur galli, et immittuntur bufones qui ova foveant, quibus datur panis in cibum. Fotis autem ovis egrediuntur pulli[1] sicut pulli gallinarum, quibus post dies septem crescunt caudæ serpentium, statimque, si non esset pavimentum domus lapideum, intrarent terram. Quod caventes eorum magistri habent vasa ænea rotunda, magnæ amplitudinis, ex omni parte perforata, quorum ora sunt stricta, quibus imponunt ipsos pullos et obstruunt ora cupreis operculis atque sub terra fodiunt, et ingrediente subtili terra per foramina nutriuntur sex mensibus. Post hæc discooperiunt et adponunt copiosum ignem, donec bestiæ interius omnino comburantur. Quo facto cum refrigeratum fuerit, eiciunt et diligenter terunt, addentes ei tertiam partem sanguinis hominis rufi, qui sanguis exsiccatus et tritus erit. Hæc duo composita temperantur aceto acro in vase mundo; deinde accipiunt tenuissimas tabulas rubei cupri purissimi, et super has liniunt hanc confectionem ex utraque parte atque mittunt in ignem. Cumque canduerint, extrahunt et in eadem confectione extingunt et lavant, sicque tamdiu faciunt donec ipsa confectio cuprum transmordeat, et inde[2] et colorem auri suscipiat. Hoc aurum omnibus operibus aptum est.

[1] "Masculi," *in Cod. Guelph.*
[2] "pondus," *id.*

CHAPTER XLVIII.

OF SPANISH GOLD.

There is also a gold called Spanish gold, which is composed from red copper, powder of basilisc and human blood and acid. The Gentiles, whose skilfulness in this art is probable, make basiliscs in this manner. They have, underground, a house walled with stones everywhere, above and below, with two very small windows, so narrow that scarcely any light can appear through them; in this house they place two old cocks of twelve or fifteen years, and they give them plenty of food. When these have become fat, through the heat of their good condition, they agree together and lay eggs. Which being laid the cocks are taken out and toads are placed in, which may hatch the eggs, and to which bread is given for food. The eggs being hatched, chickens issue out, like hens' chickens, to which after seven days grow the tails of serpents, and immediately, if there were not a stone pavement to the house, they would enter the earth. Guarding against which, their masters have round brass vessels of large size, perforated all over, the mouths of which are narrow, in which they place these chickens, and close the mouths with copper coverings and inter them underground, and they are nourished with the fine earth entering through the holes for six months. After this they uncover them and apply a copious fire, until the animals inside are completely burnt. Which done, when they have become cold, they are taken out and carefully ground, adding to them a third part of the blood of a red man, which blood has been dried and ground. These two compositions are tempered with sharp acid in a clean vessel; they then take very thin sheets of the purest red copper, and anoint this composition over them on both sides, and place them in the fire. And when they have become glowing, they take them out and quench and wash them in the same confection; and they do this for a long time, until this composition eats through the copper, and it takes the colour of gold. This gold is proper for all work.

CAPUT XLIX.

DE AURO ARENARIO.

EST aliud aurum quod dicitur harenarium, quod reperitur in littoribus Reni hoc modo. Fodiuntur harenæ in locis illis, ubi spes reperiendi est, et ponuntur super ligneas tabulas. Deinde superfunditur aqua frequenter et diligenter, effluentibusque harenis remanet aurum subtilissimum, quod singulariter in vasculo reponitur. Cumque vas dimidium fuerit, imponitur vivum argentum, et manu fortiter fricatur, donec omnino commisceatur, sicque positum in pannum subtilem extorquetur vivum argentum; quod vero remanserit ponitur in vas fusorium et funditur.

CAPUT L.

DE FABRICANDO AUREO CALICE.

IGITUR cujuscunque generis aurum habueris, si calicem inde componere volueris, et ornare lapidibus et electris atque margaritis, hoc modo incipies. Primum proba partes singulas auri, si possunt cum malleo percuti, sic ut non findantur, et quicquid non finditur singulariter pone; quod vero finditur, singulariter ut coquatur. Deinde accipe partem lateris cocti, et secundum quantitatem auri fode in eo fossuram, quæ illud capere possit; et si non habeas laterem, in lapide sabuleo item quadro, factâ fossulâ cum ferro, mitte in carbones et suffla. Cumque canduerit, impone aurum, superjectisque carbonibus suffla diutissime, atque ejectum percute cum malleo; si non frangitur, sufficit ei; si vero frangitur, super alium lapidem iterum repone, et hoc tamdiu facias,

CHAPTER XLIX.

OF GOLD SAND.

There is another gold, which is called sandy (gold), which is found upon the banks of the Rhine in this manner. The sands are dug up in those places where there is expectation of finding it, and are put upon wooden tables. Then water is frequently and carefully poured upon them, and, the sand flowing away, a very fine gold remains, which is replaced in a small vessel separately. And when the vase is half full, quicksilver is placed in and it is rubbed strongly with the hand until it is quite mixed together, and thus placed in a fine cloth, the quicksilver is squeezed from it; but what remains is placed in a crucible and is melted.

CHAPTER L.

OF MAKING THE GOLDEN CHALICE.

Whatever kind of gold then that you may have, if you wish to make a chalice from it, and ornament it with stones and coloured gems and pearls, you begin in this manner. First, prove separate pieces of gold, if they can be beaten with the hammer without breaking, and what is not broken place by itself, but that which is broken, separate, that it may be cooked. Then take a piece of burnt brick, and according to the quantity of gold carve a hollow in it, which can contain it; and if you have not brick, a hollow being made in a sandy and square stone, place it in the fire and blow upon it. And when it has become hot, place in the gold, and coals being laid upon it blow for a very long time, and being taken out beat it with a hammer; if it is not broken, it is enough for it: if however it is broken, replace it upon another stone,

donec percussum non frangatur[1]. Quo facto omne aurum pariter funde, et in unam massam redige, atque super stateram eo modo, quo argentum superius divisisti, divide; parique ordine secundum formam quam volueris, sicque pro ut libuerit auriculas formabis. Quod si opere gemmato facere volueris, percute duas partes auri tam tenues, ut vestigium ungulæ possit ei imprimi, et eas incide eâ formâ, quâ volueris auriculas habere, quæ partes utræque ad unam auriculam pertinent. Deinde compone solidaturam hoc modo.

CAPUT LI.

DE SOLIDATURA AURI.

TOLLE cineres fagineos, et fac inde lexivam, quam rursum colabis per eosdem cineres, ut spissa fiat. Rursum mitte in patellam et coque usque ad tertiam partem, et impone ei modicum smigmatis et parum arvinæ suillæ veteris. Cumque frigidum fuerit et resederit, cola diligenter per pannum et mitte in vas cupreum, quod sit ex omni parte solidum, excepto modico foramine, quod superius emineat, rotundum, ut possit digito obstrui. Post hæc tolle partem cupri tenuem, quem madefacies aqua, et fricabis super eam salem ex utraque parte, mittesque in ignem, et cum canduerit extingue in pelvi munda et pura aqua, in qua servetur quicquid ex cupro comburitur. Rursumque frica salem supra cuprum et fac sicut prius, et hoc tamdiu donec sufficiat. Deinde effunde aquam et exsicca pulverem in cupreo vase, et tere eum in eodem vase cum ferreo malleo donec tenuissimus fiat, ponensque super carbones rursum combure, atque ut prius tere.

[1] "Quod si modice finditur, funde illud cum sulphure, et sic emendabitur." *Ex Cod. Guelph. interpolantur.*

and you must do this until it cannot be broken when struck[1]. Which being done melt all the gold alike, and reduce it into one mass, and divide it upon the balance in that manner in which you divided the gold above; and in the like order you will fashion the handles, according to the form you may wish, and as it may please you. But if you should wish to make it with a gemmed work, beat two pieces of the gold so thin that a mark of the nail can be impressed upon it, and cut them out in that form which you wish the handles to have, which pieces both belong to one handle. Then compose the solder in this manner.

CHAPTER LI.

OF THE SOLDER OF GOLD.

TAKE beech-wood ashes, and make a lye from them, which you will again strain through the same ashes that they may become thick. Place them again in the pot, and cook them to one-third of the bulk, and put into it a little soap and a little fat of an old pig. And when it has become cold and has reposed, strain it carefully through a cloth, and place it in a copper vessel which is sound everywhere with the exception of a small hole, which may appear at the top, round, so that it can be stopped with the finger. Afterwards take a piece of thin copper, which you moisten with water, and you will rub the salt over it on each side, and you place it in the fire, and when it has glowed, extinguish it in a clean basin with pure water in which may be kept all the copper burned. And again rub the salt over the copper, and do as before, and this, until at length there be enough. Then pour out the water and dry the powder in a copper vessel, and grind it in the same vessel with an iron mallet until it becomes very fine. And placing it over the coals, again burn

[1] *Here there is an addition, apparently an interpolation, in the Wolfenbüttel MS. Lessing's Ed.* "But if it is broken a little, melt it with sulphur, and it will thus be remedied."

Cumque imposueris smigma, commisce diligenter, ponensque super prunas pariter combure fortiter ac denuo tere. Postea ex anteriori vase funde lexivam in illud, in quo est pulvis, et commisce atque fac bullire diu, et cum frigidum fuerit refunde simul cum pulvere ubi prius erat, ubi etiam quatuor particulas cupri impones, per quas commisceatur pulvis per omnia quotiens volueris. Hac confectione solidatur aurum et argentum; sed in solidando auro commoveatur pulvis, ut supra dictum est, in argento vero solidando non moveatur.

CAPUT LII.

DE IMPONENDA SOLIDATURA AURO.

HIS ita compositis accipe illas duas partes auri, quibus auriculas[1] formasti, et pone coram te gemmasque quas imponere volueris, pone super eas, et margaritas[2], unamquamque in suo loco. Deinde percute aurum gracile et longum, et trahe inde fila grossa, mediocria et subtilia, et lima ea ferro supradicto, ita ut in eis grana formentur. Quibus recoctis, repositis et colligatis singulariter gemmis, partem majoris fili, aptabis cum forcipe subtili, circa oram auris in utrisque partibus illis, et cum forcipe incisorio facies subtilissimas incisuras in circuitu, quibus confirmabis ipsa fila ne cadant, donec solidentur. Postmodum accipe partem auri tenuem et ligneo malleo æquatam, et colloca super eam fila mediocria multum ordinatim, ita ut non sibi adhæreant, sed habeant spatia inter se; in summitatibus eorum fiant subtiles incisuræ in tenui auro, quibus ligentur. Acceptoque vasculo in quo est solidatura, concute fortiter, ut commisceatur pulvis, et cum penna gracili linies ipsam solidaturam super aurum illud et super fila diligenter per omnia, mittesque in ignem atque sufflabis folle et

[1] vitiosè "auriculas;" *in Cod. Guelph.* "auriculam," *videtur.*
[2] "martias," *a scriba falsò ponitur.*

it, and grind it as before. And when you have put in the soap, mix it carefully, and placing it over the live coals, again burn it strongly and grind it anew. Afterwards pour in the lye, from the first vessel, into that in which is the powder, and mix it and boil it for a long time, and when it has become cold, pour it back, together with the powder, where it was before, where you also put in four pieces of copper, by means of which the powder may be mixed together as often as you wish. With this composition gold and silver may be soldered; but in soldering gold the powder must be stirred together as mentioned above, but in soldering silver it must not be stirred.

CHAPTER LII.

OF APPLYING THE SOLDER UPON GOLD.

These things thus arranged, take those two pieces of gold from which you formed the handle, and place them before you, and lay upon them the gems which you wish to apply, and the pearls, each one in its place. Then beat gold fine and long, and draw from it wires, thick, middling and fine, and file them with the instrument indicated above, so that beads may be formed upon them. These being re-cooked, the gems being replaced and attached one by one, you will adapt a piece of the larger wire, with the fine pincers, about the edge of the handle in both its pieces, and with the cutting pincers you make very fine incisions around them, by which you will fix these wires that they may not fall off, until they are soldered. Afterwards take a piece of gold thin and smoothed with the wooden mallet, and fasten upon it smaller wires very orderly, so that they may not be close together, but may have spaces between them; at their extremities fine incisions are made in the thin gold by which they are fixed. The small vase being taken in which is the soldering, agitate it strongly, that the powder may be mixed together, and with a fine pen anoint this solder upon the gold and over the wires carefully everywhere, and place it in the fire, and you will

ore, donec videas ipsam solidaturam ita circumquaque discurrere, quasi aqua perfundatur. Et mox asperges aquâ modice atque eicies, et diligenter lavabis, rursumque super linies solidaturam, ac sicut prius solidabis, donec omnia fila firmiter stent.

CAPUT LIII.

DE IMPONENDIS GEMMIS ET MARGARITIS.

POST hæc incide per particulas quasi corrigias ita, ut unaquæque corrigia habeat filum unum, quas statim complicabis et facies inde domunculas, quibus lapides claudantur, minores et majores, ad mensuram uniuscujusque, ordinabisque eas in suis locis. Habebis quoque farinam de similagine frumenti sive siliginis, quam miscebis aqua in parvulo vasculo, et pones super carbones, ut parum calefiat; in quam tingues modice domunculas illas, unamquamque singulariter in inferiore parte sicque stabilies in suo loco. Omnibus vero stabilitis pone super carbones partem auri super quam stabilisti, donec exsiccetur humor farinæ, et mox adhærebunt. Tolle quoque fila subtilia, et percute ea modice super incudem, ita ut aliquantulum tenua sint, et tamen grana superius et inferius non procedant vel perdant formam suam inde complicabis flosculos majores et minores, unde implebis campos omnes inter domunculas; quos cum formaveris subtili forcipe, intinges eos in humida farina, sicque collocabis unamquamque in suo loco. Quo facto pone super carbones, ut siccetur, statim que superlinies solidaturam, et solidabis sicut superius. Hoc modo utrisque partibus unius auriculæ solidatis ac firmatis, conjunge eas et interpone eis fundum, in circuitu ejus juxta oram interiorem, videlicet unam tenuem partem auri, quæ sit sicut festuca, et æqualis per omnia. Quam partem cum inter illas duas junxeris, complica tres particulas ferri tenues, et fac

blow with the bellows and the mouth until you see this solder run everywhere as if water were poured over it. And immediately sprinkle it slightly with water, and take it out, and you will carefully wash it, and again anoint the solder, and will solder it as before until all the wires hold firmly.

CHAPTER LIII.

OF APPLYING THE GEMS AND PEARLS.

Afterwards cut these in pieces like straps, so that every band may have a wire, which you will bend together, and make small settings of them, by which the stones may be enclosed, large and small, to the size of each one, and you will arrange them in their places. You will also have flour of wheat or rye, which you will mix with water in a small cup, and place over the coals, that it may become a little warm; in this you dip these settings slightly, one by one, each in the lower part, and so fix them in their place. All being made fast, place the piece of gold upon which you have fastened them over the coals until the moisture of the flour is dried, and they will soon adhere. Take also the fine wire and beat it slightly upon the anvil, so that it may be rather thin, and yet that the beads above and below may not project nor lose their form: with them you will weave flowers, large and small, with which you will fill up all the grounds between the settings; when you have formed these with the fine pincers dip them into the wet flour, and you will thus put each in its place. Which being done, place it over the coals that it may become dry, and immediately anoint the soldering and solder it as above. Both pieces of one handle being soldered and made firm, join them together, and place a foundation to them around them near their inner edge, namely, a thin piece of gold, which may be like a straw, and smooth everywhere. When you have joined which piece between the two, bend three small thin pieces of iron, and make small stays which

inde retinacula, quæ teneant exteriores partes auri exterius in tribus locis, ut tertia, quæ interius juxta oras circuit, non possit disjungi. Quo facto linies ex omni parte solidaturam, et siccabis modice super ignem; dispositisque carbonibus et accensis, facies inter eos fossulam, in quam pones ipsam auriculam, et circa eam collocabis carbones ordinatim ita, ut non contingant aurum, sed in similitudinem muri ascendant in circuitu, donec emineant super aurum; et tunc collocabis desuper graciles ferros duos, vel tres, qui pertranseant. Super quos collocabis per omnia carbones, et cooperies diligenter, sic tamen ut aliqua foramina inter ipsos carbones remaneant, per quæ possis considerare, qualiter solidatura circumfluat. Quod cum videris, statim aspersa modicâ aquâ, eicies atque lavabis leniter et siccabis, circumspiciensque diligenter si quid corrigendum est, corriges; rursumque liniens sicut prius, solidabis, sicque facies, donec per omnia firmum fiat. Hoc modo parem auriculam formabis atque solidabis. Quo peracto junge eas utrasque ad vas calicis in suis locis, et circa eas facies duos tractus in ipso vase cum subula, per quos possis considerare, ut recte stent in solidando. Deinde funde purum aurum et admisce ei tertiam partem cupri rubei et puri, quod pariter fusum et modice percussum limabis penitus et pones in pennam anseris. Post hæc accumula ante fornacem magnum acervum carbonum, et in eis pone vas calicis, ita ut medietas ejus omnino sub carbonibus sit, et illa pars omnino emineat, super quam una pars auris ponenda est; quam statim conjunges ei, et linies ipsum vas cum auricula interius et exterius cum solidatura, atque limaturam, quod in penna posueras, seminabis circa juncturas, qua auris vasi conjungitur, sicque circumposito igne aggerabis carbones in circuitu, sicut superius fecisti, circa auriculam, et ferros desuper compones, quos carbonibus abundanter cooperies. In anteriori vero parte intra cavum vasis compone carbones in similitudinem modici furni, ut carbones in circuitu densi jaceant, et

can hold the outer pieces of gold in three places outside, so that the third which compasses the inside near the edge, cannot be disunited. This being done, anoint the solder everywhere, and you will dry it a little over the fire, and the coals being arranged and glowing you make a hollow among them, in which you place the handle, and about this you will arrange the coals in order, so that they may not touch the gold, but rise around it like a wall, until they dominate the gold; and you will then place above it two or three slight pieces of iron, which may pass across. Over this you will place the coals everywhere, and cover it carefully, so however that some openings may remain among these coals, through which you can see how the solder flows. When you see which instantly sprinkle it with a little water: you take it out and will gently wash and dry it, and, carefully considering it, if there is any fault you correct it, and again anointing it as before, you will solder it, and do this until it is made firm everywhere. In this manner you will make the other handle and solder it. Which being accomplished, join them both to the cup of the chalice in their places, and make two lines upon the cup itself with a graver, by means of which you can see whether they are placed straight in soldering. Then melt pure gold, and mix with it a third part of red and pure copper, which likewise, fused and slightly beaten, you will file altogether and place in a goose quill. After this accumulate before the furnace a great heap of coals, and place in them the cup of the chalice, so that half of it may be altogether under the coals, and that part upon which a part of the handle is to be placed may altogether rise above them; you immediately join which (handle) on to it, and anoint the vase with the handle inside and out with the soldering, and you will scatter the filings which you had placed in the quill inside and out with the solder, about the junction by which the handle is united to the cup, and thus, fire being placed around, you will heap the coals in a circle, as you did before about the handle, and place the irons over it, which you cover plentifully with coals. In the front part within the hollow of the cup place the coals in the shape of a small furnace, so that the coals may lie

foramen in medio appareat per quod possit sufflari, ut calor superius et inferius æqualis sit. Cumque videris solidaturam circumfluere, et quasi tertio inundare, asperge diligenter modicâ aquâ, et eiciens lava et sicca, rursumque simili modo solida, et tamdiu donec firmissimè adhæreat. Conversumque vas in alteram partem, parem auriculam eodem modo conjunge et solida.

CAPUT LIV.

DE ELECTRO.

QUO facto tolle partem auri tenuem et conjunge ad oram vasis superiorem, atque metire ab una auricula usque ad alteram; quæ pars[1] latitudinis sit, quanta est grossitudo lapidum, quos imponere volueris; et collocans eos in suo ordine, sic dispone; in primis stet unus lapis quatuor margaritis in angulis positis, deinde electrum, juxta quod lapis cum margaritis, rursumque electrum, sicque ordinabis ut juxta auriculas semper lapides stent, quorum domunculas et campos, easque domunculas, in quibus electrum ponendum est, compones et solidabis ordine quo supra. Et in altera parte vasis similiter facies. Si vero volueris in medio ventris gemmas et margaritas ponere, eodem modo facies. Quo facto conjunges eas et solidabis sicut auriculas. Post hæc in omnibus domunculis, in quibus electra ponenda sunt, coaptabis singulas partes auri tenues, conjunctasque diligenter eicies, atque cum mensura et regula incides corrigiolam auri quod aliquantulum sit spissius, et complicabis eas circa oram unius cujusque partis dupliciter, ita ut inter ipsas corrigiunculas subtile spatium sit in circuitu, quod spatium vocatur limbus electri. Deinde eâdem mensurâ atque regulâ incides corrigiolas omnino subtilissimi auri, in quibus subtili forcipe complicabis et

[1] "tantæ," *in Cod. Guelph.*

thickly around the circumference, and that a small opening may appear in the midst, through which it can be blown, that the heat above and below may be equal. And when you see the solder flow about, and as if undulating, a third time, sprinkle it carefully with a little water, and taking it out, wash and dry it, and again solder it similarly, and until it adhere very firmly. And turning the vase on the other side, join and solder the fellow handle in the same manner.

CHAPTER LIV.

OF COLOURED GLASS STONES (OR ENAMEL).

Which being done, take a thin piece of gold and join it to the upper rim of the vase, and measure it out from one handle to the other; this piece must be of the breadth as is the size of the stones which you wish to place upon it; and, arranging them in their order, thus dispose them; first a stone must stand, four pearls being placed at its angles, then a glass gem, next this a stone with pearls, and again a glass gem; and you will so arrange them that the stones may always stand next the handles, the settings and grounds of which, and those settings in which the glass gem is to be placed, you compose and solder in the order above. And you do the same on the other side of the vase. If however you wish to place gems and pearls in the centre of the body, you act in the same manner. This being done, join and solder them as the handles. After this you will adapt thin pieces of gold in all the settings in which the glass gems are to be placed, and, carefully fitted, you take them out, and with a measure and rule you cut a small band of gold, which must be somewhat thicker; and you will bend them round the rim of each piece in a double manner, so that a minute space may exist around between these small bands: this space is called the border of the enamel. Then, with the same measure and rule you cut small bands of exceedingly thin gold, in which you will bend and fashion whatever work

formabis opus quodcunque volueris in electris facere, sive circulos, sive nodos, sive flosculos[1], sive aves, sive bestias, sive imagines, et ordinabis particulas subtiliter et diligenter unamquamque in suo loco, atque firmabis humidâ farinâ super carbones. Cumque impleveris unam partem, solidabis eam cum maxima cautela, ne opus gracile et aurum subtile disjungatur aut liquefiat, sicque bis aut ter facies, donec aliquantulum singulæ particulæ adhæreant.

Hoc modo omnibus electris compositis et solidatis accipe omnia genera vitri, quod ad hoc opus aptaveris, et de singulis partibus parvum frangens colloca omnes fracturas simul super unam partem cupri, unamquamque partem per se; mittensque in ignem compone carbones in circuitu et desuper, sufflansque diligenter considerabis si æqualiter liquefiant: si sic, omnibus utere; si vero aliqua particula est durior, singulariter repone. Accipiensque singulas partes probati[2] vitri, mitte in ignem singillatim, et cum canduerit, proice in vas cupreum in quo sit aqua, et statim resiliet minutatim, quod mox confringas cum rotundo malleo donec subtile fiat, sicque lavabis et pones in concham mundam, atque cooperies panno lineo. Hoc modo singulos colores dispones. Quo facto tolle unam partem auri solidati, et super tabulam æqualem adhærebis cum cera in duobus locis, accipiensque pennam anseris incisam gracile sicut ad scribendum, sed longiori rostro et non fisso, hauries cum ea unum ex coloribus vitri, qualem volueris[3]. Quod vero superfuerit repone in vasculum suum et cooperi, sicque facies ex singulis coloribus, donec pars una impleatur; auferens ceram cui inhæserat, pone ipsam partem super ferrum tenue, quod habeat brevem caudam, et cooperies cum altero ferro quod sit cavum in similitudinem vasculi, sitque per omnia transforatum gracile, ita ut foramina sint interius plana et latiora, et exterius subtiliora et hispida, propter arcendos

[1] "sive aures," *in MS. videtur.*

[2] "auri," *in MS. interponitur.*

[3] "qui erit humidus, et cum longo cupro gracili et in summitate subtili rades a rostro pennæ subtiliter et implebis quemcunque flosculum volueris, et quantum volueris," *ex Codice Guelph.*

you may wish to make in enamel, whether circles, or knots, or small flowers, or birds, or animals, or figures; and you will arrange the small pieces delicately and carefully, each in its place, and will fasten them with moistened flour over the coals. When you have filled one portion, you will solder it with the greatest care, that the slender and fine gold may not be disjoined nor liquefy; and do thus twice or three times, until the separate pieces adhere a little.

All the enamels being composed and soldered in this manner, take all kinds of glass which you had prepared for this work, and breaking a particle from each piece, place all the fragments together upon a piece of copper, each piece by itself, and placing it in the fire arrange the coals around and above it, and blowing carefully, you will see whether they melt equally; if so, use them all; if however any particle is harder (than the rest) place it by itself. Taking separate pieces of the proved glass, place them in the fire one by one, and when each one has become glowing, throw it into a copper vessel in which there is water, and it instantly flies into small fragments, which you break with a round pestle until made quite fine, and you will thus wash it and put it into a clean vessel, and you cover it with a linen cloth. In this manner you prepare the separate colours. Which being done, take a piece of the soldered gold, and you will fasten it upon a smooth table with wax in two places, and taking a goose quill cut to a point, as if for writing but with a longer beak and not split, you take out with it one of the colours of glass, whichever you please[1]. That which remains over, replace in its small cup and cover it, and do this with each colour until one piece is filled: taking away the wax, to which it had adhered, place this piece upon a thin iron, which may have a short handle, and cover it with another iron which is hollow like a cup, and let it be perforated finely all over, so that the holes may be inside flat and wide, and outside finer and

[1] "which must be moist, and with a long copper instrument, slender, and fine at the end you scrape from the beak of the pen, delicately, and will fill up whatever flower you wish, and how you please,"—*an interpolation in the Wolfenbüttel Manuscript.*

cineres, si forte superceciderint; habeatque ipsum ferrum in medio superius brevem annulum, cum quo superponatur et elevetur. Quo facto compone carbones magnos et longos, incendens illos valde; inter quos facies locum et æquabis cum ligneo malleo, in quem elevatur ferrum per caudam cum forcipe; ita ut coopertum collocabis diligenter, atque carbones in circuitum compones et sursum ex omni parte, acceptoque folle utrisque manibus undique sufflabis donec carbones æqualiter ardeant. Habeas etiam alam integram anseris, sive alterius avis magnæ, quæ sit extensa et ligno ligata; cum qua ventilabis et flabis fortiter ex omni parte, donec perspicias inter carbones ut foramina ferri interius omnino candeant, sicque flare cessabis. Expectans vero quasi dimidia hora discooperies paulatim donec omnes carbones amoveas, rursumque expectabis donec foramina ferri interius nigrescant, sicque elevans ferrum per caudam, ita coopertum pones retrò fornacem in angulo donec omnino frigidum fiat. Aperiens vero tolles electrum et lavabis, rursumque implebis et fundes sicut prius, sicque facies donec liquefactum æqualiter per omnia plenum sit. Hoc modo reliquas partes compones.

CAPUT LV.

DE POLIENDO ELECTRO.

QUO facto, tolle partem ceræ ad longitudinem dimidii pollicis, in quam aptabis electrum ita, ut cera ex omni parte sit, per quam ceram tenebis[1]. Deinde super duram cotem et æqualem fricabis diutissime donec claritatem acci-

[1] "et fricabis ipsum electrum super lapidem sabuleum æqualem diligenter cum aqua, donec aurum æqualiter appareat per omnia," *ex Cod. Guelph.*

rough, in order to stop the cinders if by chance they should fall upon it; this iron may also have a small ring above, in the middle, by which it may be superposed and taken off. Which being done, arrange large and long coals, making them very hot, among which you make a space, and equalize with a wooden mallet, into which the iron is raised by the handle with the pincers, so that when covered you will place it carefully and arrange the coals round and above it everywhere, and taking the bellows with both hands you will blow on every side until the coals glow equally. You have also a wing of a goose, or other large bird, which is extended and tied to wood, with which you will wave and fan strongly all over it, until you perceive between the coals that the holes of the iron quite glow inside, and thus you will cease to fan. Waiting then about half an hour you uncover by degrees until you remove all the coals, and you will again wait until the holes of the iron grow black inside, and so raising the iron by the handle, you place it, covered as it is, in the furnace, behind, in a corner until it has become quite cold. Then opening it you take out the enamel and will wash it, and will again fill it and melt as before, and you do thus until, melted equally everywhere, it has become full. In this manner you compose the remaining pieces.

CHAPTER LV.

OF POLISHING THE COLOURED GLASS ORNAMENT, (OR ENAMEL.)

This being done, take a piece of wax the length of half a thumb, in which you will fix the enamel so that the wax may be all round it; by this wax you will hold it[1]. Then you will rub it for a long time upon a hard and smooth hone, until it

[1] "and you will rub this electrum upon a smooth sandy stone carefully with water, until the gold appear equally everywhere." *From the Wolfenbüttel MS.*

piat; sicque super eandem cotem saliva humidam fricabis partem lateris, quæ ex antiquis vasculis fractæ reperiuntur, donec saliva spissa et rubea fiat; quam linies super tabulam plumbeam æqualem, super quam leniter fricabis electrum usque dum colores ejus translucidi fiant et clari; rursumque fricabis laterem cum saliva super cotem, et linies super corium hyrcinum, tabulæ ligneæ æqualiter affixum; super quod polies ipsum electrum donec omninò fulgeat, ita ut si dimidia pars ejus humida fiat et dimidia sicca sit, nullus possit considerare, quæ pars sicca, quæ vel humida sit.

CAPUT LVI.

DE PEDE CALICIS ET PATENA ATQUE FISTULA.

DEINDE funde aurum in quo formabis pedem cum nodo, in cujus nodi medio atque in ora pedis in circuitu dispones limbum cum lapidibus et electris ut supra. Patenam quoque cum formabis[1] mensurâ et formâ, quâ volueris, circa oram ejus eodem opere et ordine limbum operaberis, facies et fistulam auream ordine et modo quo superius argenteam.

Cruces quoque et plenaria et sanctorum pignorum scrinia, simili formâ cum lapidibus et margaritis[2] deornabis.

CAPUT LVII.

DE COLATORIO.

FACIES quoque colatorium aureum sive argenteum hoc modo. Percute vas parvulum ad similitudinem modicæ pelvis, latitudine modice amplius unius palmæ[3], (cui impones caudam longitudinis unius ulnæ et) latitudine unius pollicis,

[1] *imò* "formaveris."
[2] "atque electris," *in Cod. Guelph.*
[3] *Ex Cod. Guelph. desunt in Manuscripto Harleo.*

acquires a polish; and you will also rub upon the same stone, wetted with saliva, a piece of potter's ware, which is found amongst the fragments of ancient vases, until the saliva has become thick and red; this you anoint upon a flat leaden tablet, upon which you will lightly rub the glass stone until at length their colours appear transparent and clear: and you will again rub the clay ware upon the hone with saliva, and you anoint it upon a goat skin, smoothly fixed upon a wooden table; upon this you polish this electrum until it shines perfectly, so as if one half of it were wet and one half were dry, no one could distinguish which was the wet or which the dry part.

CHAPTER LVI.

OF THE FOOT OF THE CHALICE, THE PATENA, AND THE PIPE.

THEN melt the gold of which you will form the foot with the knot, in the centre of which knot and in the rim of the foot around, you arrange the border with stones and glass gems as above. Also when you have formed the patena in the size and shape you may wish, and shall have fashioned a border around its rim in the same work and order, you make the golden pipe in the same order and manner as the silver (pipe) above mentioned. You will also decorate crosses and caskets and shrines of holy relics in a similar fashion with stones and pearls[1].

CHAPTER LVII.

OF THE STRAINER.

YOU also make a golden or silver strainer in this manner. Beat out a small cup like a small basin, in length rather more than a palm, ([2]to which you place a handle a yard in length)

[1] "and enamels," *Wolfenbüttel MS., is added.*

[2] From the Wolfenbüttel MS.

quæ cauda habebit in summitate caput leonis fusile et decentissimè sculptum, quod caput tenebit pelviculam in ore suo. Habebit etiam in altera summitate caput simili modo sculptum, in cujus ore pendebit anulus, per inserto digito portari possit. Reliqua vero cauda inter duo capita decorari debet nigello per loca, et per loca opere fusili et punctorio et litteris versuum exarari in suo loco. Pelvicula vero quæ in summitate est, in medio fundo perforari debet, latitudine duorum digitorum in rotunditate, subtilissimis foraminibus per quæ colari debet vinum et aqua in calicem ponenda, per quam[1] sacramentum Dominici sanguinis conficitur.

CAPUT LVIII.

DE AMPULLA.

SI vero volueris ampullam componere ad fundendum vinum, percute argentum eodem modo, quo percutitur nodus pedis in calice, excepto quod venter ampullæ multo latior debet formari, et collum ejus super incudem longam et gracilem malleo corneo et mediocri ferreo debet constringi. Interdum etiam ipsa ampulla, cum cœperit formari, impleatur cerâ et malleo mediocri ferreo leniter percutiatur, ut ei rotunditas ventris et effigies colli decentius et æqualius aptetur. Sicque ejectâ cerâ super carbones iterum recoquatur, et denuo cera imponatur, ac sicut prius percutiatur, donec omnino formetur. Quo facto si volueris in ipsa ampulla imagines aut bestias sive flores opere ductili facere, compone in primis confectionem ex pice et cera et tegula.

[1] *Codex Guelph.*, "quæ," *habet; i. e. vinum et aqua.*

and the breadth of a thumb, which handle will have a lion's head at the extremity, cast and properly sculptured, which head will hold the small basin in his mouth. It will also have at the other end a head carved in a similar manner, in the mouth of which a ring will hang, by means of which it can be carried, the finger being inserted. The remainder of the handle between the two heads should be decorated in places with niello, and in places be ornamented with molten and point work and letters of verses in their places. The small cup, which is at the extremity, should be perforated at bottom in the centre, of the size of two fingers in circumference, with very fine holes, through which the wine and the water to be placed in the chalice should run, by means of which the sacrament of the Lord's blood is accomplished.

CHAPTER LVIII.

OF THE VIAL.

But if you wish to make the vial for pouring out the wine, beat the silver in the same manner as the knot of the foot of the chalice is beaten, excepting that the body of the vial should be formed much wider, and its neck be narrowed upon a long and slender anvil with the moderate-sized horned and iron hammer. Sometimes also the vial, when its formation has commenced, may be filled with wax, and be lightly struck with the middling iron hammer, that the roundness of the body and the shape of the neck may be more properly and evenly trimmed. And thus, the wax being taken out, it may again be re-heated upon the coals, and the wax again be put in, and it may be beaten as before until it is altogether formed. Which being done, if you wish to make upon the vial figures, or animals, or flowers in beaten work, first compose the mixture of pitch and wax and tile.

CAPUT LIX.

DE CONFECTIONE QUÆ DICITUR TENAX.

TERE partem lateris sive tegulæ minutissimè, et liquefac picem in testa ollæ, modicumque ceræ adde. Quibus pariter liquefactis commisce pulverem tegulæ et fortiter commove atque in aquam effunde. Cumque cœperit refrigerari, intingue manus utrasque in aquam et macera diu, donec possis ipsam confectionem extendere et trahere sicut pellem. Hanc confectionem statim liquefacies et implebis ampullam usque ad summum. Cumque refrigerata fuerit, pertrahe in ventre et in collo quodcumque volueris, tollensque ferros ductorios graciles et parvulum malleolum designa quod pertraxisti, in circuitu, leniter percutiendo. Deinde da puero, qui contra te sedat, malleolum et tu tene in sinistra manu ampullam, et dèxterâ ferros, unumquodque in suo loco, et fac puerum percutere quocumque modo volueris, leniter aut fortiter, ac depone campos, ut cavi fiant et opus elevetur. Cumque per omnia semel percusseris, appositâ ampullâ igni, eice confectionem, recoctâque ampullâ, ejectâ ab igne, rursum imple eam, ac sicut prius percute sicque facies donec omnes campos æqualiter deponas, et omne opus ita conformes ut appareat quasi fusum sit. Hoc autem omnino procura ut argentum ampullæ ita spissum sit, ut cum opus percutiendo formaveris, cum ferris fossoriis possis illud decenter incidere, fodere et radere. Quo peracto, si volueris, fac auriculam fusilem eodem modo quo formasti auriculas argentei calicis, et in anteriori parte deductorium, unde vinum effundatur, quæ confirmabis solidaturâ, argento et cupro mixtâ, ut supra. Deinde, ubicumque volueris, nigello ornabis, et reliquum deaurabis ut supra.

Eodem modo facies cyphos aureos et argenteos atque scultellas, et pixides ad oblatas imponendas et capsulas thymiamatis; et manubria in cultellis, et imagines in crucibus et plenariis ex auro sive argento aut cupro.

CHAPTER LIX.

OF THE COMPOSITION WHICH IS CALLED TENAX.

Grind a piece of brick or tile very small, and melt some pitch in an earthenware pot and add a little wax. These being melted together, mingle the powder of the tile, and stir it strongly and pour it into water. And when it has begun to grow cold, dip both hands into the water and macerate it for a long time, until you can extend and draw out this composition like a skin. You instantly melt this composition and will fill the vial to the top. And when it has become cold, portray in the body and in the neck whatever you wish, and taking slender ductile instruments and a small hammer, design that which you have portrayed around it, by striking lightly. Then give the hammer to the boy, who may sit opposite you, and hold the vial in your left hand, and the instruments in your right, each one in his place; and make the boy strike them in what mode you please, slightly or strongly, and depress the grounds that they may become hollow, and the work be raised. And when you have beaten it once throughout, the vial being brought to the fire, eject the composition, and the vial being reheated and taken from the fire again, fill it and beat as before, and do thus until you depress all the grounds equally, and you fashion all the work, so that it may appear as if cast. Above all arrange that the silver of the vial be so thick that when you have formed the work by beating, you may be able to chase, hollow, and scrape it properly with the sculping instruments. Which being accomplished, if you wish, make the cast handle in the same manner as you formed the handles of the silver chalice, and the spout where the wine is poured out; these you will fasten with solder, made with silver and copper as above. Then you will ornament with niello wherever you may wish, and gild the remainder as above.

You make in the same manner gold and silver cups and plates and boxes for placing the wafers and incense caskets; also handles for knives and figures upon crosses and missals in gold, or silver, or copper.

CAPUT LX.

DE THURIBULO DUCTILI.

SI vero thuribula ductili opere componere volueris in auro, vel argento, sive cupro, primum purificabis ordine quo supra, atque fundes in fusoriis ferris duas marcas vel tres sive quatuor, secundum quantitatem quam vis habere superiorem partem thuribuli. Deinde attenuabis in rotulam eo ordine quo superius calicem argenteum majorem, excepto quod hoc opus spissius et profundius ducendum est interius, ut altius sit exterius, ita ut altitudo in se ipsius latitudinem totam habeat et ejus medietatem. Cujus altitudinem cum produxeris, priusquam latitudinem constringas, pertrahe in eo turres, videlicet in supremo unam octoangulatam, in qua fiant ejusdem numeri fenestræ, sub qua fiant quatuor quadratæ, quibus singulis imponantur tres columpnæ, et inter eas duæ fenestræ productæ, in quarum medio super mediam columnam fiat fenestella rotunda; sub quibus in tertio loco formentur aliæ turres octo; quatuor videlicet rotundæ contra superiores quadras, in quibus fiant flosculi aut aviculæ vel bestiolæ, sive fenestellæ, et inter eas quatuor quadræ, quæ et latiores sint, in quibus fiant dimidiæ imagines angelorum, quasi in eis cum alis suis sedentium. Sub quibus in ipsa rotunditate vasis fiant quatuor arcus in supremo modice producti, in quibus fiant evangelistæ sive in specie angelorum, seu in figura animalium; inter quos arcus super ipsam oram rotunditatis ponantur quatuor capita leonum sive hominum fusilia, per quæ catenæ transeant. His ita pertractis, cum ferris ductoriis et malleis, interius et exterius percutiantur, donec omnino formentur, sicque limentur et radentur, ferrisque fossoriis fodiantur. Hæc est superior pars turibuli. Deinde percutiatur inferior cum suo pede, in quo fiant quatuor arcus, qui respondeant superioribus, in quibus sedeant quatuor flumina

CHAPTER LX.

OF THE BEATEN CENSER.

If however you should wish to make a censer in beaten work, in gold, silver, or brass, you will first purify it in the above order, and you pour into the iron moulds, two, or three, or four marks, according to the quantity which you wish the upper portion of the censer to possess. You will then thin it in a circle in the same way as the larger silver chalice above mentioned, excepting, that this work is thicker and is to be depressed deeper inside, that it may be higher outside, so that its height may possess the whole of its breadth and one half of it. When you have lengthened out its height, before you limit the breadth, portray towers in it, namely, on the top, one octangular, in which the same number of windows are made; under which four square towers are made, upon every one of which three columns are placed, and between them two lengthened windows, in the midst of which, over the middle column, a small round window is made: under these, in the third place, eight other towers are made; namely, four round, against the upper squares, in which are made small flowers, or birds, or animals, or small windows, and between these four square (towers) which may be yet broader, in which the half figures of angels are made, as if resting in them with their wings. Under which, in the rounding itself of the vase, four arches are made, a little drawn out at the top, in which are made the evangelists, whether in likeness of angels, or in figures of animals; between these arches, upon the edge of the rounding, four heads of lions are placed, or of men, cast, through which the chains may pass. These things thus portrayed, they are struck out with the ductile and hammering irons, inside and outside, until they are altogether shaped, and are thus filed and rasped and chased with the sculping instruments. This is the upper part of the censer. Then the lower part with its foot is struck out, in which four arches are made which may correspond to those above, in which may rest the four rivers of Paradise, in human

Paradysi humana specie cum suis amphoris, quibus effundatur quasi species fluentis aquæ. In angulis vero, quibus conjunguntur circuli, figantur capita leonum sive facies hominum de quibus supra diximus, ita ut inferiori parte adhæreant facies in quibus firmentur catenæ, et in superiori capilli vel comæ, per quas transeant ipsæ catenæ. Quod si pes cum ipsa inferiori parte nequeat percuti, fiat singulariter sive ductili sive fusili opere, et imponatur cum solidatura argento et cupro mixtâ, de qua supra diximus. Lylium vero cui anulus imponendus est, et cui catenæ superius infigendæ sunt, fiat similiter ductili sive fusili opere, in quo formentur flores aut aviculæ sive bestiolæ secundum qualitatem inferioris operis. Hoc turibulum si fuerit argenteum aut cupreum, poterit deaurari ordine quo supra. Quod si quis voluerit laborem apponere, ut turibulum pretiosioris operis componat, similitudinem civitatis, quam vidit propheta in monte, hoc modo exprimere poterit.

CAPUT LXI.

DE THURIBULO FUSILI.

TOLLE argillam non commixtam et bene maceratam, et fac siccare ad solem, siccatamque comminue et diligenter cribra. Cribratamque aquâ commisce et fortiter macera, et exinde compone tibi duas massas, ad magnitudinem quam vis habere turibulum, unam inferiorem, et alteram superiorem quæ [1] latior erit; quæ massæ vocantur nuclei. Quos statim perforabis ligno in longitudine in quatuor costis æqualiter inciso, sicque siccabis ad solem. Post hæc transduces eis ferrum, quod dicitur tornatile, longum et mediocriter gracile, quod sit in una summitate grossius in quatuor costis æqualiter percussum, ac magis magisque gracile deductim usque in finem, in cujus grossiori parte inponatur aliud ferrum

[1] "altior" in Cod. Guelph.

form with their urns, from which may be poured a likeness of flowing water. In the angles, by which the circles are joined together, the heads of lions, or human faces, of which we have before spoken, may be fixed, so that the faces may adhere in the lower part in which the chains are fixed, and in the upper, the manes or hair through which these chains may pass. But if the foot cannot be beaten with the lower part itself, it is made alone, in cast or beaten work, and can be placed on with the solder made with silver and copper, of which we have before spoken. Also the lily, to which the ring is attached and to which the chains are fixed above, is similarly made with ductile or molten work, in which flowers, or small birds or beasts are formed, according to the quality of the labour below. If this censer be silver or brass, it can be gilt in the manner before mentioned.

But should any one wish to apply more labour, so as to compose a censer of more costly work, he can, after this manner express the likeness of the city which the prophet saw upon the mount.

CHAPTER LXI.

OF THE CAST CENSER.

Take clay, unmixed and well beaten, and dry it in the sun, and being dry, carefully grind and sift it. Being sifted, mix it with water, and beat it strongly, and make two masses of it of the size which you wish the censer to possess, one lower, and another upper (mass) which will be wider; these lumps are called the "nuclei." You will directly pierce these with a piece of wood cut lengthwise, smoothly upon the four sides, and will thus dry them in the sun. Afterwards pass an iron through them, which is called the turning iron, long and rather slender, which is thicker at one end, smoothly beaten on the four sides, and diminishing more and more slenderly towards the point; in the thicker part of this another iron

breve et curvum, sive lignum, cum quo possit circumverti. Deinde habebis duas columnellas ligneas super scamnum fixas et ab invicem sejunctas secundum longitudinem ferri, quæ singulæ habeant in anteriori parte singulos clavos similiter ligneos, ad mensuram palmi longos, et ad similitudinem gradus incisos; super quos ponatur lignum aliud rotundum, ita ut possit propius et longius removeri, super quod requiescat manus tornantis. His ita compositis inter ipsas duas columpnellas pone ferrum tornatile, quod nucleos continet, et coram te ad lævam manum sedente adjutore, qui circumvertat illud, tornabis ferris acutis et latioribus ex omni parte usque ad æqualitatem, sicque formabis nucleos illos ut sibi conjungantur æquali latitudine et spissitudine in medio. Intercides vero inferiorem partem a medietate inferius, ita, ut latitudo superior duabus mensuris inferiorem superet, in qua formabis et pedem. Eâdem quoque mensurâ intercides superiorem partem, cujus tamen altitudo tanta erit, ut intercidatur[1] ad similitudinem lignei campanarii, ita ut quælibet incisura sursum magis gracilis sit. His ita tornatis eice ferrum, et cum cultello incide in latiori limbo superioris nuclei quatuor angulos usque ad incisuram, quæ ei proxima est, ita ut in crucis modum formetur, et unumquodque cornu æquales habeat latitudines in parietibus, sed altitudine contineat mensuram et dimidiam latitudinis; in qua etiam pinnacula ad similitudinem tectorum formabis. Facies quoque in proxima turri octo costas, quatuor latiores, et quatuor strictiores quas etiam rotundas facies, ita ut anguli latiorum promineant, et strictiorum cavi sint, ut sic rotunditas appareat; in quibus ad mensuram tecta convenientia formabis. Turrem vero penultimam eodem modo formabis, sicut tamen ut rotundæ costæ super inferioris latas formentur, et inferioris rotundæ sub superiorum latis aptentur. Superior vero turris octo costis æqualiter latis et absque tectis formetur. Hæc erit superior pars turibuli.

[1] "ter" *in Cod. Guelph. interponitur.*

short and bent, must be fixed on, or a piece of wood, with which it can be revolved. You will then have two small wooden columns fixed upon a bench and separated from each other according to the length of the iron, each of which may have in the front part single wedges, also wooden, in measure a palm in length, and cut like a ladder; upon which another round wood may be placed, so that it can be moved nearer or farther: upon this the hand of the turner can rest. These things thus arranged place, between these two columns the turning iron which holds the "nucleus," and the assistant who may turn it sitting before you upon the left hand, you will turn it with sharp and wide instruments everywhere until it is smooth, and you will so form these "nuclei" that they may be joined together by an equal breadth and thickness in the middle. You will cut in the lower part from the middle downwards, so that the upper breadth may by two measures exceed the lower, in which you will also form the foot. In the same proportion also you cut the upper part, the height of which, however, will be such that it is cut in (three times), to the shape of a bell-founder's wooden (block), so that every cutting may be slighter upwards. These being thus turned, take out the iron, and with a knife cut, in the broader border of the upper nucleus, four angles as far as the nearest cutting, so that it may be formed in the manner of a cross, and let each projection have equal breadth in the sides, but contain in height a measure and a half of the breadth, in which you will form also small pinnacles in likeness of roofs. You also make in the next tower eight ribs, four wide and four narrow, which you also make round, so that the angles of the wider may project, and of the narrower be hollow, so that a roundness may appear; in these you will form proper roofs to the size. You will fashion the penultimate tower in the same manner, so, however, that round ribs are formed over the broad parts of the lower, and that the round parts of the lower are adjusted under the broad parts of the upper. But the upper tower must be formed with eight ribs, equally broad and without roofs. This will be the upper part of the censer.

[1] "three times," *from the Wolfenbüttel MS.*

Inferioris autem partis latior limbus, incisis angulis similiter in crucis modum formabitur, ut superiori coaptetur, et inferior limbus in rotundum finiatur. His taliter aptatis tolle duo ligna ad longitudinem pedis et grossitudinem quam ceram habere volueris, aliudque lignum tantæ longitudinis rotundum et grossum ut hasta lanceæ; et habebis ascellam latam longitudine pedis, et duabus ulnis longam et valde æqualem, super quam configes prædicta duo ligna, ita ut a se spatio dimidii pedis disjuncta lignum contra lignum æqualiter aptetur. Deinde tolle ceram puram quam igni appositam fortiter macerabis, sicque calidam inter duo ligna super ascellam collocabis, prius aqua subposita ne adhæreant, et illud rotundum lignum madefactum utrisque manibus fortiter superducens secundum spissitudinem lignorum attenuabis. Et cum multas partes æquales ceræ paraveris, sedens juxta ignem incide eas particulatim secundum spatia, quæ in argilla turibuli incideras, et unicuique spatio suam particulam modice calefactam aptabis, atque cum ferro ad hoc opus apto et calefacto circumsolidabis. Cumque hoc modo totum nucleum exterius cooperueris, accipe ferrum tenue ex utraque parte acutum in modum gracilis sagittæ, cum parvula cauda, ligneo manubrio infixum, et cum illo ex omni parte circumcides, et buxeo ligno eodem modo formato planabis, et ut in nullo[1] loco cera spissior sive tenuior sit quam in alio, procurabis. Deinde pertrahe in singulis frontibus singulos arcus, et in obliquis parietibus similiter, et sub singulis arcubus ex utraque parte singulas valvas, ita ut unaquæque valva quartam partem spatii contineat, et duæ partes in medio remaneant; in quibus spatiis pertrahes sub unoquoque arcu singulas imagines apostolorum, quæ singulæ teneant singulos breves, effigie qua volueris, quorum nomina scribes in limbo circa arcus. In spatiis vero triangulis, qui tectorum pinnas sustinent, formabis similitudinem lapidum duodecim, disponens unicuique apostolo convenientem lapidem, secundum significationem nominis sui, quo-

[1] "illo," *vitiosè in MS. videtur.*

In the lower part a wider border will be formed, the angles being likewise cut in form of a cross, that it may be fitted to the upper, and a lower border is defined around. These being thus adjusted, take two pieces of wood a foot in length and the thickness which you wish the wax to possess, and another wood of equal length, round and thick as the stem of a lance; and you will have a small tablet a foot wide and two yards long and very smooth; upon this you fix the two pieces of wood before mentioned, so that being separated from each other by the space of half a foot, wood may be evenly adjusted against wood. Then take pure wax which, placed near the fire, you will strongly pound, and, thus warm, you will place it upon the table between the two woods, water being first applied that they may not adhere; and passing over it the wetted round wood strongly with both hands, you will thin it according to the thickness of the pieces of wood. And when you have prepared many even pieces of wax, sitting near the fire, cut them small according to the spaces which you had cut in the clay of the censer, and you will adjust to each space its piece slightly warmed, and with an iron, fit for this work, and made warm, you will solder it round. And when you have covered in this manner all the "nuclei" outside, take a thin iron, sharp on both sides like a slender arrow with a small handle, fixed in a wooden handle, and with this cut it round everywhere, and you will smooth it with box-wood made in the same fashion, and you will take care that the wax be in no place thicker or thinner than in another. Then portray single arches in each front and the like upon the side walls, and single folding doors under each arch on every side, so that each folding door may cover a fourth part of the space, and that two parts may remain in the middle; in these spaces under each arch, you trace single figures of the apostles, each of which may hold a writing of the pattern you wish; you will write their names in the border around the arches. In the triangular spaces, which support the pinnacles of the roof, you will fashion a representation of twelve stones, distributing a proper stone to each apostle according to the signification of its name; the names of these

rum nomina scribes in inferiori limbo ejusdem spatii, et in singulis angulis juxta lapides facies singulas fenestellas. Hæc erit similitudo de qua propheta dicit: Ab Oriente portæ tres, et ab Occidente portæ tres, et a Meridiano portæ tres, et a Septentrione portæ tres. In quatuor autem angulis, qui sunt inter divisiones portarum, formabis in cera singulas turriculas rotundas, per quas catenæ transibunt. His ita dispositis facies in proxima superiori turri singulas imagines angelorum integras in quadrangulis spatiis, ([1] cum scutis et lanceis suis, quasi ad custodiam murorum stantes, et in rotundis turriculis formabis columnellas cum capitellis suis et basibus. Eodem modo facies in penultima turri, quæ brevior est, dimidias imagines angelorum et pari modo columnellas. In superiori vero turri, quæ gracilior erit, facies fenestras longas et rotundas, et in summitate turris propugnacula in circuitu, in quorum medio formabis agnum, et in capite ejus coronam et crucem, et circa dorsum ejus brevem arcum, in cujus summitate sit anulus, cui imponatur media catena. Hæc est superior pars thuribuli cum opere suo.

Inferiori vero parte simili modo coopertâ cerâ, formabis in singulis spatiis singulas imagines prophetarum cum suis brevibus, et aptabis unicuique apostolo convenientem prophetam, ut testimonia eorum, quæ brevibus sunt inscribenda, sibi concordent.) Circa prophetas vero non facies portas, sed tantum spatia earum sint quadrangula, et in limbis super capita scribantur eorum nomina. Facies quoque in angulis quatuor turres in quibus catenæ firmentur ut superioribus coaptentur. In inferiori vero rotundo spatio facies circulos quot potueris, vel volueris, in quibus formabis singulas imagines virtutum dimidias, specie femininâ quarum nomina scribes in circulis. Ad postremum autem in fundo formabis pedem et tornabis, et omnia spatia circa imagines superius et inferius erunt transforata. Deinde unicuique parti suis infusoriis atque spiraculis inpositis, circumlinies diligenter argillam tenuem et siccabis ad solem, rursumque et tertio facies similiter; quæ partes vocantur

[1] *Eadem verba et sequentia usque ad* "sibi concordent" *omittit Cod. Harl. Addidimus ex Cod. Guelph.*

you write in the lower border of the same space, and in each angle, next the stones, you make small windows. This will be a likeness of which the prophet says: "On the East three gates; on the North three gates; on the South three gates; and on the West three gates." In the four angles which are between the divisions of the doors, you will form single round turrets, through which the chains will pass. These things thus disposed, you make on the top of the upper tower, in the square spaces, single entire figures of angels, (with their shields and lances as if standing on guard upon the walls, and in the round turrets you will fashion small columns with their capitals and bases. In the same manner you make in the last tower but one, which is shorter, half images of angels, and in the same way of columns. And in the upper tower, which will be more slender, you make long and rounded windows, and on the top of the towers bulwarks around; in the middle of these you will fashion a lamb, and upon its head a crown and cross, and about its back a small arch, in the top of which a ring must be, to which the middle chain is fixed. This is the upper part of the censer with its work.

In the lower part, similarly covered with wax, you will form in each space single figures of the prophets with their writings, and will adapt to each apostle a corresponding prophet, that their testimonies, which are inscribed upon the scrolls, may agree with each other[1].) But you make no doors around the prophets, but only let the spaces be quadrangular and their names be written upon the borders over their heads. You also make in the angles four towers, in which the chains are fixed that they may be fitted with those higher up. In the lower round space you make as many circles as you can or wish, in which you form single feminine half figures of the virtues, the names of which you write in the circles. At the last also you will fashion and turn the foot, and all the spaces about the figures above and below will be transpierced. Then, the tunnels and air holes being placed in every part, you plaster thin clay carefully about it, and will dry it in the sun, and you do this again, and a third time; these parts are

[1] *The text within these brackets is taken from Lessing's Ed. of the Wolfenbüttel MS., by the scribe omitted here.*

jam formæ. Quas omnino siccatas pones ad ignem, et cum calefactæ fuerint, ceram liquescentem funde in aquam, rursumque pone ad ignem, sicque facies donec ceram omnino eicias. Post hæc in loco apto et æquali pones carbones grossos et frigidos, super quos stabilies formas, foraminibus inferius conversis, et circumpones eis lapides duros, qui resilire non possint ad calorem ignis, et ordinabis eos lapidem super lapidem in similitudinem muri absque temperamento siccos, ita ut inter lapides multa foramina et parvula remaneant. Quibus ita compositis, altius quam formæ sint spatio dimidii pedis, circumfunde carbones ardentes, ac deinde frigidos usque ad summum, et cave ut tantum spatii sit inter formas et lapides, quod carbones capere possit. Cumque carbones omnes incanduerint, interdum gracili ligno movendi sunt circumquoque per foramina inter lapides ut se conjungant, et calor ex omni parte æqualis sit. Et cum in tantum descenderint ut formas videre possis, iterum imple frigidis carbonibus usque ad summum, sicque tertio facies. Et cum videris formas exterius candescere, pone vas in ignem cum auricalco quod fundere volueris, et primum modice, deinde magis magisque sufflabis, donec omnino liquefiat. Quo facto cum curvo ferro et in ligno infixo diligenter commove, et vas in latus aliud converte; rursumque auricalco imple et calefac, sicque facies donec vas plenum fiat, et denuo cum curvo ferro commovebis, et a carbonibus purgabis, et sufflatore fortiter flante cooperies magnis carbonibus. Deinde amotis lapidibus formas eicies ab igne, et argillam abundanter aquâ perfusam atque in modum fecis attenuatam cum panno diligenter circumlinies, sicque juxta fornacem, in quam fundis, fossâ factâ formas inpone et terram circumquaque exaggera, et ligno inferius æquali crebrius inpingendo diligenter comprime. Statimque habeas præ manibus panniculum multipliciter complicatum et fisso ligno impositum, ejectoque vassiculo ab igne cum forcipe curvato rostro, et panniculo apposito, qui sordes et favillas de-

now called moulds. You place these, perfectly dry, at the fire, and when they have become warm, pour out the melted wax into water, and you again place them at the fire, and you do thus until you have removed all the wax. After this you lay large and cold coals in a fit and smooth place, upon which you establish the moulds with the openings turned downwards, and you place around them some hard stones which cannot fly to pieces by the heat of the fire, and you will arrange them stone upon stone like a wall, dry without mortar, so that between the stones many small openings may remain. These being thus arranged, higher by half a foot than are the moulds, spread around the hot coals, and then the cold, unto the top, and take care that such space be between the moulds and the stones as may contain the coals. When all the coals are glowing, they are sometimes to be stirred with a thin wood on every side through the openings between the stones, that they may be closed together, and the heat be equal everywhere. And when they have descended so much that you can see the moulds, again fill up to the top with cold coals, and do thus a third time. And when you see the moulds glow outside, place the vessel in the fire with the brass which you wish to cast, and you will blow slightly at first, then more and more until it be quite liquefied. This being done, carefully stir it with an instrument bent and fixed in wood, and turn it into another wide (vessel), again fill it with brass and heat it, and do thus until the vessel be filled, and you will again stir it with the curved instrument and will purge it from coals, and blowing strongly with the bellows you will cover it with large coals. The stones being then removed, you take the moulds from the fire and carefully plaster clay, plentifully sprinkled with water and thinned like lees, with a cloth, and so a trough being made near the furnace in which you found, you place in the moulds and heap up earth on every side and carefully compress it with a piece of wood flat at the bottom, by frequently pounding it. And directly have ready a small cloth many times folded and placed in a piece of split wood, and the vessel being taken from the fire with the pincers curved at the end, and the small cloth being applied which can defend it from dust and

fendat, diligenter infunde. Hoc modo formis utrisque fusis sine stare, donec infusorium superius nigrescat; deinde remota terra et a fossis extractas repone in tuto loco, donec omnino frigescant, cavens summopere ne calidis formis aquam superjacias, quia interiores nuclei, si humorem persenserint, statim inflantur et omne opus disrumpetur. Cumque per se refrigeratis argillam removeris, diligenter circumspice, et si quid negligentiâ vel casu defuerit, locum illum circumlimandum attenuabis, et apposita cera, nec non argilla addita, cum sicca fuerit, calefacies, sicque superfundes, donec rivo in partem decurrente, quod superfundis adhæreat. Quod cum respexeris, si minus firmum fuerit, cum combustione viniceæ petræ, et limaturâ ex mixtura argenti et cupri, sicut præscripsimus, solidabis. Post hæc diversis limis quadrangulis, triangulis, atque rotundis campos omnes primo translimabis. Deinde ferris fossoriis fodies, et rasoriis rades; ad ultimum sabulo cum lignis in summitate modice conquassatis undique purgatum opus deaurabis.

CAPUT LXII.

DE CATENIS[1].

CATENAS facturus primum trahe fila subtilia sive grossiora in cupro sive argento, et circumflecte cum subula in tribus auriculis, aut quatuor, vel quinque, sive sex, secundum grossitudinem quam volueris, ad mensuram uniuscujusque turibuli minoris sive majoris. Et cum omnes catenas unius turibuli in unam partem plexueris, tolle lignum tenue ex quercu sive fago, et fac in eo multa foramina cum gracili ferro rotundo et calido, per quæ foramina catenam igne recoctam et refrigeratam transduces et denuo recoques, rursumque per aliud foramen transduces et recoques, sicque facies, donec per omnia æqualiter sit grossam et rotundam. Deinde incide ip-

[1] vitiose "chatenis" *in MS. Harlei.*

cinders, carefully pour in. The two moulds being in this manner founded, allow them to remain until the funnel above grow black; then, the earth being removed, taking them from the trough, place them in a safe place until they grow quite cold, above all things taking care that you cast no water over the hot moulds, because the nuclei which are inside are instantly swelled if they feel humidity, and all the work is burst asunder. When they have cooled by themselves you remove the clay, and carefully examine them; and if anything be deficient through negligence or casualty, filing about that place you will thin it, and wax being applied and the clay added, when dry you warm it, and thus found over it, until that which you pour over adhere, the jet flowing over the place. When you have examined this, should it be insecure, you will solder it with the burnt wine stone and the filing from the mixture of silver and copper, as we have before prescribed. After this, with different files, square, triangular, and round, you will first file across all the surfaces. You then sculp them with the sculping instruments, and scrape them with the scrapers; at last, the work being cleansed everywhere with sand with wood slightly crushed at the end, you will gild it.

CHAPTER LXII.

OF THE CHAINS.

In making the chains, first first draw out very fine, or thicker, wires in copper or silver, and bend them with the bodkin into three, or four, or five, or six ears, according to the breadth you may wish, to the proportion of each large or small censer. And when you have bent all the chains of one censer in one piece take a thin wood of oak or beech, and make numerous holes in it with a pointed iron instrument, round and hot; through these holes you draw the chain, cooked in the fire and again cooled, and you again cook it; again you draw it through another hole and re-cook it, and you act thus until it is equally thick and round. Then cut this chain into pieces,

sam catenam per partes ad quantitatem turibuli, mediam autem partem breviorem, et longiores reliquas; aptatis foraminibus in utrisque summitatibus catenarum, obfirmabis eas, quæ longiores sunt, in inferiore parte turibuli clavis firmis et transductis; compositæ per superiorem partem impones anulos parvulos, cum quibus aptabis et obfirmabis eas ad lilium inferius, per quod manu gestari debet cum magno anulo eidem superius imposito. Mediam vero catenam, quæ brevior est, obfirmabis clavo in superiori parte turibuli in uno capite, et alterum imposito anulo aptabis inferius sub lilio; et sic procurabis ut turibulum ex omni parte æqualiter pendeat.

Possunt etiam eodem modo et ordine, quo prædiximus, turibula diversæ formæ et diversi operis percuti et fundi in auro et argento atque auricalco. Sed magnopere cavendum est, ut auricalcum, quod deaurari debet, omnino purum sit et purgatum a plumbo, propter diversa infortunia, quæ deaurantibus evenire solent. Quod auricalcum si vis componere, primò naturam cupri, ex quo efficitur, disce.

CAPUT LXIII.

DE CUPRO.

CUPRUM in terra nascitur. Cujus vena cum invenitur, summo labore fodiendo et frangendo acquiritur. Est enim lapis colore viridis ac durissimus et plumbo naturaliter mixtus. Qui lapis abundanter effossus rogo inponitur et comburitur in modum calcis, nec tamen mutat colorem, sed duritiam amittit ut confrangi possit. Deinde minutatim confractus fornaci imponitur, follibus atque carbonibus adhibitis, incessanter die ac nocte conflatur. Quod ipsum diligenter et caute fieri debet; id est, ut primo carbones inponantur[1], et

[1] "Deinde lapidis minutiæ superfundantur, rursumque carbones." *Ex Cod. Guelph.*

according to the size of the censer, the middle piece, however, shorter, the rest longer; openings being adapted at both ends of the chains, you will fasten the longest of them to the lower part of the censer with solid nails passed through them; joined together at the upper part, you place small rings upon them, with which you will adjust them and fasten them upon the lily at bottom, by which it should be carried in the hand with a large ring placed upon its summit. But the middle chain, which is shorter, you will fasten by a nail to the upper part of the censer at one end, and you will adjust the other under the lily by a ring placed below; and you will thus take care that the censer may hang equally on every side.

Censers of various forms and various workmanship can be beaten and founded in gold and silver and brass, in the same manner and fashion as we have related. But it is greatly to be heeded that the brass, which should be gilt, be quite pure and purged from lead, on account of divers mishaps which are wont to happen to the gilders. If you wish to compose this brass, first learn the nature of copper, from which it is made.

CHAPTER LXIII.

OF COPPER.

COPPER is engendered in the earth. When a vein of which is found, it is acquired with the greatest labour by digging and breaking. It is a stone of a green colour, and most hard and naturally mixed with lead. This stone, dug up in abundance, is placed upon a pile and burned, after the manner of chalk, nor does it change colour, but yet loses its hardness, so that it can be broken up. Then, being bruised small, it is placed in the furnace; coals and the bellows being applied, it is incessantly forged by day and night. This should be done carefully and with caution; that is, at first coals are placed in, ([1] then small pieces of stone are distributed over them, and

[1] *From the Wolfenbüttel MS.*

denuò lapis ; sicque fiat donec ad capacitatem sufficiat fornacis. Cumque lapis cœperit liquefieri, per cavernulas quasdam plumbum effluit et cuprum intro remanet. Quod cum diutissime conflatum fuerit, refrigeratum et eicitur, et rursum aliud eodem ordine imponitur. Huic cupro taliter fuso admiscetur quinta pars stagni, et conficitur metallum, quo campanæ funduntur.

Invenitur etiam genus lapidis subcrocei coloris, et interdum rufus, qui calamina dicitur, qui non confractus [1], miscetur carbonibus omnino comminutis, et supradicto cupro in fornace commiscetur, quod hoc modo componitur.

CAPUT LXIV.

DE FORNACE.

STANT quatuor lapides in modum crucis, a se longitudine unius pedis separati, partim in terra firmati, sed altitudine pedis unius super terram æqualiter prominentes, et omnes in superiori parte æquales. Super hos lapides ponuntur quatuor ferri quadranguli grossitudine unius digiti, et longitudine ut possint ab uno lapide ad alterum protendi. Inter hos medii ponuntur alii ferri ejusdem mensuræ, æquali spatio, id est latitudine trium digitorum a se separati: super quos etiam in transverso ponuntur alii formâ et mensurâ inferiorum æquali, ita ut foramina videantur esse quadrangula. His ita distinctis, super ipsos ferros ponatur argilla fortiter macerata et fimo equi commixta, spissitudine trium digitorum, ita ut ipsis ferris atque lapidibus ex omni parte adhæreat, et ita sit, quasi lares rotunda super lapides jaceat. Deinde cum rotundo

[1] "Sed ita ut effoditur, lignis congestis et abundanter succensis imponitur, et donec omnino candeat comburitur. Qui lapis post hæc refrigeratus et minutissime confractus." *Ex Cod. Guelph.*

again coals,) and the stone anew; and it is thus arranged until it is sufficient for the size of the furnace. And when the stone has commenced to liquefy, the lead flows out through some small cavities, and the copper remains within. When this has been blown upon for a very long time, and cooled, it is taken out and other is again placed in after the same order. To this copper thus melted a fifth part of tin is added, and a metal is made with which bells are founded.

A kind of stone is also found of a yellowish colour, and sometimes red, which is called calamine, which is not broken up, ([1] but as it is dug up it is placed upon wood, heaped up and very glowing, and is burned until it quite glows. This stone, afterwards cooled and broken very small,) is mixed with coals finely divided, and is mingled with the above-mentioned copper in the furnace, which is composed in this manner.

CHAPTER LXIV.

OF THE FURNACE.

Four stones, in the fashion of a cross, stand, separated from each other the length of a foot, partly fixed in the earth, but rising equally to the height of a foot above the ground, and all equal at the upper part. Upon these stones four square irons are placed, of the thickness of a finger, and of a length that they can be laid across from one stone to another. Between these, other intervening irons are placed of the same size, at an equal distance, that is, separated from each other by a breadth of four fingers: upon these also others, equal in form and measure to those below, are placed across, so that the openings may appear to be square. These being thus separated, clay, strongly beaten and mixed with horse dung, is placed upon the same irons, to the thickness of three fingers, so that it may adhere to these irons and stones everywhere, and appear as if a round hearth lay upon the stones. Then with a round wood openings are made in

[1] *From the Wolfenbüttel MS.*

ligno in spatiis inter ferros foramina fiant per omnia quanto possint ampliora; et sic diligenter siccetur.

Deinde ab ipso[1] sursum fiat murus cum minutis lapidibus, et eadem argillâ in modum ollæ, ita ut a medietate superius aliquantulum strictior sit, et fiat altior quam latitudo sit, atque cum ligaminibus ferreis quinque aut quatuor circumligetur, et eadem argilla interius et exterius diligenter illiniatur. Quo facto imponantur carbones ardentes commixti extinctis, et mox ventus per inferiora foramina ingrediens absque flatu follis educit flammas, et quicquid metalli inponitur statim per se liquescit. Post hæc hoc modo componantur vascula huic operi necessaria.

CAPUT LXV.

DE COMPOSITIONE VASORUM.

TOLLE fragmina veterum vasorum, in quibus ante cuprum sive auricalcum fusum fuerat, et super lapidem minutatim confringe. Deinde accipe terram, ex qua fiunt ollæ, cujus genera sunt duo; unum album, aliud grisium; ex quibus album valet ad colorandum aurum, aliud vero ad hæc vasa componenda; et cum minutissimè contriveris, hanc crudam terram in mensura commisces alteri, id est combustæ, quam primum triveras, hoc modo. Accipe vas quodcunque et imple illud bis ex cruda terra, et ter ex cocta, ita ut duæ partes sint crudæ et tres coctæ, et ponens simul in vas magnum perfunde aqua tepida, et malleis ac manibus fortiter macera, donec omnino in se tenax sit. Deinde lignum rotundum incide ad mensuram, quam volueris habere vasam, secundum quantitatem fornacis, et super illud formabis vasculum unum, et formatum mox circumlinies cineribus siccis, et sic juxta ignem pone donec siccetur. Hoc modo

[1] "lare." *Ex. Cod. Guelph.*

the spaces between the irons everywhere, as many as possible; and so it is carefully dried.

Then, from the same (hearth), a wall may be made with minute stones and the same clay, after the fashion of a pot, so that from the middle upwards it may be somewhat narrower, and may be higher than broad, and it is bound round with four or five iron bands, and the same clay is carefully plastered inside and out. Which being done, glowing coals, mixed with cinders, are placed in, and soon the wind, entering through the holes below, nourishes the flames without the breath of the bellows, and whatever metal is placed in immediately liquefies by itself. Afterwards the small cups necessary for this work are made in this manner.

CHAPTER LXV.

OF THE COMPOSITION OF THE VASES.

Take fragments of old vases, in which copper or brass has been before fused, and break them small upon a stone. Then take the earth of which pots are made, of which kinds there are two, one white, another grey; of these the white is useful for colouring gold, but the other for composing these vases; and when you have ground it together very finely, you mingle this crude earth with the other, in proportion, that is, to the burnt material which you first ground, in this manner: Take any vase and fill it twice with this crude earth, and three times with the burnt (fragments), so that two parts may be crude and three burnt, and placing them together in a large vase, pour warm water over them, and beat strongly with mallets and the hands until it has become quite tenacious. Then cut wood round, to the size which you wish the vase to possess, according to the capacity of the furnace, and upon it you will form a small vase, and being made, you directly cover it round with dry ashes, and so place it near the fire until it be dry. In this manner make as many vases as you

compone vasa quot volueris. Sed cum diligenter siccata fuerint, pone in fornacem tria vel quatuor aut quinque, in quantum fornax capere possit, et circumfunde carbones.

CAPUT LXVI.

DE COMPOSITIONE ÆRIS.

CUMQUE canduerit[1], tolle calaminam, de qua supra dixi, cum carbonibus minutissimam tritam, et in singulis vasculis quasi ad sextam partem compone, et penitus eam cupro supradicto imple et carbonibus cooperi. Interdum etiam cum ligno gracili et recurvo foramina inferius inpinge, ne fortè obstruantur, ut et favillæ exeant ventusque magis ingrediatur. Cum vero cuprum omnino liquefactum fuerit, tolle ferrum gracile, longum et curvum, ligneoque manubrio infixum, et diligenter commove, ut calamina cupro commisceatur. Postea autem cum forcipe longo vascula singula modicum eleva et a locis suis paululum remove, ne fortè lari adhæreant, rursumque in omnibus ut prius calaminam pone, et cupro reple atque carbonibus cooperi. Cumque denuò penitus liquefactum fuerit, rursumque diligentissimè commove, et cum forcipe vas unum eiciens, sulcis in terra fossis totum effunde, vasque in suo loco repone. Et mox sumens calaminam, ut prius impone, cuprumque quod effudisti, quantum capere possit superpone. Eoque ut prius liquefacto commove et calaminam repone, atque effuso cupro reple et sine liquefieri. Sic singulis vasis facito. Cumque per omnia penitus fuerit liquefactum atque diutissime commotum, effunde ut prius, et serva donec opus habueris. Hæc commixtio vocatur æs, unde caldaria, lebetes et pelves funduntur, sed non potest deaurari, quando ante commixtionem cuprum non fuit penitus a plumbo purgatum. Deinde facturus auricalcum, quod possit deaurari, sic incipe.

[1] "canduerint," *imò.*

wish. But when they have been carefully dried, place three, four, or five in the furnace, as much as the furnace can contain, and heap coals over them.

CHAPTER LXVI.

OF THE COMPOSITION OF BRASS.

WHEN they are glowing, take calamine, of which I have before spoken, very finely ground, with coals, and arrange them in each cup about one sixth part full, and fill it quite with the above-mentioned copper, and cover with coals. From time to time prick the openings below with a slender and curved piece of wood, that they may not by chance be obstructed, so that the ashes may fall out, and the wind may have more access. And when the copper is altogether melted, take a slender iron, long and curved and fixed to a wooden handle, and carefully stir it, that the calamine may be mixed with the copper. But after this, with the long forceps slightly raise the vases separately, and remove them a little from their places, that they may not by chance adhere to the hearth; and again, as before, place calamine in all of them, and refill them with copper, and cover them with coals. When they have anew become quite fluid, again carefully stir them, and taking out one vase with the forceps, pour out the whole into the trench dug in the earth, and return the vase to its place. Taking calamine, directly replace it as before, and place upon it as much of the copper which you poured out as the vessel can contain. And being liquefied as before, stir it and re-add calamine, and fill it up with the copper (you) poured out, and leave it to be melted. Do this to each of the vases; and when in all it has become melted, and has been stirred for a long time, pour out as before and keep it until you have need. This mixture is called brass, from which caldrons are cast, but it cannot be gilt when the copper has not been entirely purged from lead before mixture. Then in making brass which can be gilt, begin thus.

CAPUT LXVII.

DE PURIFICATIONE CUPRI.

TOLLE patellam ferream cujus magnitudinis volueris, et lini eam interius et exterius argillâ fortiter maceratâ et mixtâ, et diligenter exsiccatâ. Deinde pone eam ante fornacem ferrarii super carbones, ita ut cum folles flaverint, ventus partim interius partim superius procedat et non inferius. Et circumpositis minutis carbonibus, æqualiter inpone cuprum, et superadde congeriem carbonum. Quod cum diu sufflando fuerit liquefactum, discooperi et mox minutam carbonum favillam super illud proice, et cum ligno gracili et sicco quasi miscendo commove, videbisque statim plumbum combustum ipsi favillæ quasi gluten adhærere. Quo ejecto iterum carbones superpone, ut primo diu sufflans, rursumque discooperi, et tunc fac ut ante fecisti. Quod tamdiu facies donec plumbum omnino excoquendo eicias. Deinde infunde super infusorium, quod ad hoc aptaveris, et sic probabis si purum sit. Tene illud cum forcipe ita candens, prius quam refrigeretur et percute grandi malleo super incudem fortiter, et si frangitur aut finditur, denuo oportebit illud liquefieri sicut prius. Si vero sanum permanserit, refrigerabis in aqua, et aliud eodem modo coques. Hoc cuprum vocatur torridum. Ex hoc cupro quicquid facere volueris ductili opere, in imaginibus, et bestiis et avibus, in turibulis et diversis vasis, in limbis tabularum, in filis et catenis, ad deaurandum operari poteris. Ex hoc cupro confice auricalcum cum adjectione calaminæ, eodem modo quo superius æs caldariorum composuisti. Quod cum quater aut quinquies recoxeris in vasculis furno impositis, quicquid exinde in diversorum operum varietate fuderis, optime deaurare poteris.

CHAPTER LXVII.

OF THE PURIFICATION OF COPPER.

Take an iron dish of the size you wish, and line it inside and out with clay strongly beaten and mixed, and it is carefully dried. Then place it before a forge upon the coals, so that when the bellows act upon it the wind may issue partly within and partly above it, and not below it. And very small coals being placed round it, place the copper in it equally, and add over it a heap of coals. When, by blowing a long time, this has become melted, uncover it and cast immediately fine ashes of coals over it, and stir it with a thin and dry piece of wood as if mixing it, and you will directly see the burnt lead adhere to these ashes like a glue. Which being cast out again superpose coals, and blowing for a long time, as at first, again uncover it, and then do as you did before. You do this until at length by cooking it you can withdraw the lead entirely. Then pour it over the mould which you have prepared for this, and you will thus prove if it be pure. Hold it with the pincers, glowing as it is, before it has become cold, and strike it with a large hammer strongly over the anvil, and if it be broken or split, you must liquefy it anew as before. If, however, it should remain sound, you will cool it in water, and you cook other (copper) in the same manner. This copper is called burnt. From this copper you can work whatever you may wish to make, for gilding, in ductile work, in figures and animals and birds, in censers and different vases, in borders of tablets, in wires and chains. Make auricalcum from this copper with the addition of calamine, in the same manner as you have composed the brass of caldrons above. When you have recooked this four or five times in small vessels placed in the furnace, whatever you have cast from it in a variety of divers work, you can gild in the best manner.

CAPUT LXVIII.

QUALITER DEAURETUR AURICALCUM.

DEAURARE vis igitur thuribulum ex auricalco, fac eodem modo sicut superius deaurasti auriculas argentei calicis, sed cum majori cautela, quia argentum et simplex cuprum facilius deaurari possunt quam auricalcum. Debet enim morosiùs et diligentius invivari et spissius deaurari, et frequentius lavari, et diutius siccari. Quod cum cœperit croceum colorem trahere, si videris albas maculas undique ex inde exire, ut nolint æqualiter siccari, hæc est culpa calaminæ, quod non fuit[1], bene purgatum et excoctum, quod sic emendabis. Tolle smigma et pone in vasculum mundum, et infunde ei aquam, et digitis tuis quasi lavando commisce diligenter, donec fiat quasi fex cerevisiæ, atque cum setis porci linies illud æqualiter per omnia super deauratum turibulum. Deinde pone super carbones, et tam diu calefac, donec confectio illa incipiat nigrescere, et sic elevans cum forcipe per omnia diligenter asperges aquâ, sicque lavabis, et cum filis ex auricalco, ut supra dictum est, polies. Quo facto rursum circumfricabis cum confectione vinicei lapidis, et vivo argento, et denuo deaurabis propter calorem carbonum, qui sæpius in illud mittuntur, ne fortè, si tenue deauratum fuerit, ipsum aurum comburatur, sicque iterum polies cum filis, ac denuo super carbones pones diutius calefaciens, donec rubeum colorem trahat, et mox refrigerabis in aqua, et cum ferris æqualibus et ad hoc aptis polies, sicque cum atramento combusto incolorabis, ut prædiximus.

[1] "æqualiter commixta, sive plumbi, quod cuprum non fuit" *Ex Cod. Guelph.*

CHAPTER LXVIII.

HOW FINE BRASS CAN BE GILT.

Do you therefore wish to gild a censer, of fine brass, do in the same manner as above, when you gilded the handles of the silver chalice, but with greater care, because silver and simple copper can be more easily gilt than auricalcum. It should also be more warily and carefully revived, and more thickly gilt, also more frequently washed and longer dried. When it has begun to show a yellow colour, if you see white spots spread all over it, which will not become equally dry, this is the effect of the calamine, which was not well purged and cooked[1], which you will thus remedy. Take soap and place it in a small clean cup and pour water upon it, and with your fingers, as if in washing, mix it carefully until it has become like the lees of beer, and with hog's bristles anoint it smoothly every where over the gilt censer. Then place it upon the coals and heat it until this mixture begins to blacken, and so raising it with the pincers, sprinkle it with water every where, and thus you will wash it, and you polish it with brass wires as before mentioned. Which being done, you will again rub it around with the wine-stone and quicksilver, and will gild it anew, on account of the heat of the coals which are more often placed in it, unless by hazard, if it were thinly gilt, the gold itself may be burnt, and again you polish it with the wires, and place it anew upon the coals, warming it for a longer time, until it shows a red colour, and you will immediately cool it in water, and polish it with smooth instruments proper for this work, and will colour it with atrament, burnt, as we have before said.

[1] which was not well mixed, or of lead which was not well purged and cooked from it. *From the Wolfenbüttel MS.*

CAPUT LXIX.

QUALITER SEPARETUR AURUM A CUPRO.

QUOD si aliquando vasa cuprea seu argentea deaurata fregeris, vel aliud quodlibet opus, hoc modo aurum separare poteris. Tolle ossa cujuscumque animalis volueris, quæ per plateam inveneris, et conbure, quæ refrigerata minutatim tere, et tertiam partem cinerum ex fago admisce, et fac testas sicut in purificando argento ut superius diximus; quas igne sive sole siccabis. Deinde aurum a cupro diligenter abrades, et ipsam rasuram complicabis in plumbo tenue percusso, atque una ex testis illis coram fornace prunis imposita, jam que calefactæ ipsam complicaturam plumbi cum rasura impònes, et superjectis carbonibus conflabis. Cumque liquefactum fuerit, eo modo quo solet argentum purificari, interdum prunas amovendo et plumbum addendo, interdum recoquendo et morosè flando combures, donec cupro penitus absumpto, purum aurum appareat.

CAPUT LXX.

QUOMODO SEPARETUR AURUM AB ARGENTO.

CUM raseris aurum de argento, imponas ipsam rasuram in vasculum, in quo solet aurum vel argentum liquefieri, et super inprime panniculum lineum, ne fortè quid inde eiciatur a vento follis, atque coram fornace ponens liquefac; et mox fragmina sulphuris inpone, secundum quantitatem ipsius rasuræ, et cum carbone gracili diligenter commove, donec fumus ejus cesset; statim effunde in ferrum infusorium. Deinde super incudem leniter percute, ne fortè quid inde resiliat illi nigri, quod sulphur combussit, quia ipsum argentum

CHAPTER LXIX.

HOW GOLD IS SEPARATED FROM COPPER.

But if at any time you have broken copper or silver gilt vessels, or any other work, you can in this manner separate the gold. Take the bones of whatever animal you please, which (bones) you may have found in the street, and burn them, being cold, grind them finely, and mix with them a third part of beech-wood ashes, and make cups as we have mentioned above in the purification of silver; you will dry these at the fire or in the sun. Then you carefully scrape the gold from the copper, and you will fold this scraping in lead beaten thin, and one of these cups being placed in the embers before the furnace, and now become warm, you place in this fold of lead with the scraping, and coals being heaped upon it you will blow it. And when it has become melted, in the same manner as silver is accustomed to be purified, sometimes by removing the embers and by adding lead, sometimes by re-cooking and warily blowing, you burn it, until, the copper being entirely absorbed, the gold may appear pure.

CHAPTER LXX.

HOW GOLD IS SEPARATED FROM SILVER.

When you have scraped the gold from silver, place this scraping in a small cup in which gold or silver is accustomed to be melted, and press a small linen cloth upon it, that nothing may by chance be abstracted from it by the wind of the bellows, and placing it before the furnace, melt it; and directly lay fragments of sulphur in it, according to the quantity of the scraping, and carefully stir it with a thin piece of charcoal until its fumes cease; and immediately pour it into an iron mould. Then gently beat it upon the anvil, lest by chance some of that black may fly from it which the sulphur

est. Non enim sulphur auri quicquam consumit, sed solum argentum, quod taliter ab auro separat, quodque diligenter servabis. Rursum in eodem vasculo sicut prius liquefac ipsum aurum et adice sulphur. Quo commoto atque effuso, quod nigrum fuerit frange et serva, sicque facies donec aurum purum appareat. Deinde omne illud nigrum, quod servasti diligenter, compone super testam compositam ex osse et cinere, et adice plumbum, sicque combure, ut recipias argentum. Quod si ad usum nigelli servare volueris, prius quam comburas, adde ei cuprum et plumbum secundum mensuram superius memoratam, et confunde cum sulphure.

CAPUT LXXI.

QUOMODO DENIGRETUR CUPRUM.

DE cupro supradicto, quod rubeum dicitur, fac tibi laminas attenuare[1], quantæ longitudinis velis. Quas cum incideris et aptaveris operi tuo, pertrahe in illis flosculos, sive bestias, aut aliud quod volueris, et fode cum gracili ferro fossorio. Deinde tolle oleum, quod fit de semine lini, et cum digito superlinies per omnia tenue, atque cum penna anseris æquabis, et tenens cum forcipe pones super prunas ardentes. Cumque modicum incaluerit, et oleum liquefactum fuerit, denuo cum penna æquabis rursumque impones prunis, sicque facies donec exsiccetur. Quod si videris per omnia æqualiter esse, mitte super carbones valde ignitos, et tam diu jaceat, donec cesset fumare. Et si satis nigrum fuerit, bene; sin autem, valde parum olei cum penna super calidum ita linies, æquatumque denuo conflatis carbonibus superpone, faciens sicut prius. Cumque refrigeratum fuerit, non in aqua sed per se, cum ferris rasoriis valde acutis rade diligenter flosculos, ita ut campi appareant nigri. Si vero litteræ fuerint,

[1] attenuari?

has burnt, because it is itself silver. For the sulphur consumes nothing of the gold, but the silver only, which it thus separates from the gold, and which you will carefully keep. Again melt this gold in the same small cup as before, and add sulphur. This being stirred and poured out, break what has become black and keep it, and do thus until the gold appear pure. Then gather together all that black, which you have carefully kept, upon the cup made from the bone and ash, and add lead, and so burn it that you may recover the silver. But if you wish to keep it for the service of niello, before you burn it add to it copper and lead, according to the measure mentioned above, and mix it with sulphur.

CHAPTER LXXI.

HOW COPPER IS BLACKENED.

Cause leaves of the above-mentioned copper, which is called red, to be thinned for you, of the length you wish. When you have cut and adapted these to your work, portray upon them small flowers, or animals, or other thing which you wish, and sculp it with a fine sculping iron. Then take oil which is made from linseed, and anoint it all over thinly with the finger, and smooth it with a goose feather, and holding it with the forceps, place it upon the glowing embers; and when it is a little warmed and the oil has become liquid, you will smooth it anew with the pen, and you again place it upon the embers, and do thus until it is dried. But if you see that it is smooth every where, place it over some very hot coals, and let it lie until it be dried. And if it be black enough, it is well; but if not, you anoint a very little oil with the feather over the hot copper, and being made smooth, again place it upon the lighted coals, acting as before. When they have become cold, not in water, but alone, scrape small flowers carefully with very sharp scraping instruments, so that the grounds may appear black. Should they be letters, however, it is at

in tuo sit arbitrio, utrum eas nigras volueris esse an deauratas. Cum vero lamina diligenter rasa fuerit, statim invivabis eam cum confectione vinicei lapidis et vivo argento, et mox deaurabis, deauratamque non exstingues in aqua, sed per se refrigerabitur, poliesque sicut supra dictum est, et eodem modo colorabis.

CAPUT LXXII.

DE OPERE INTERRASILI.

ATTENUA tibi laminas ex eodem cupro sicut superius, sed spissius, quas pertractas quocumque opere volueris fodies, ut suprerius. Deinde habeas ferros graciles et latiores, secundum quantitatem camporum, qui sint in una summitate tenues et acuti, in altera obtusi, qui vocantur *meizil*[1]; ponensque laminam super incudem, campos omnes perforabis, cum supradictis ferris percutiens cum malleo. Cumque omnes campi tali modo fuerint perforati, cum limis parvulis æquabis eos per omnia usque ad tractos. Quo facto deaurabis, et polies laminam, ut supra.

Eodem modo fiunt tabulæ, et laminæ argenteæ super libros cum imaginibus, floribus atque bestiolis et avibus, ex quibus pars deauratur, videlicet coronæ imaginum et capilli atque vestimenta per loca, et pars remanet argentea. Fiunt etiam et laminæ cupreæ et fodiuntur, et denigrantur ac raduntur; deinde in patella liquefacto stagno mittuntur, ut rasuræ albæ fiant, quasi deargentatæ sint. Ex his ligantur cathedræ pictæ, et sedilia, atque lecti; ornantur etiam libri pauperum.

[1] *Codex Guelpherb.* "meizel" *habet.*

your option whether you choose them to be black or gilt. When a plate has been carefully scraped, you will immediately revive it with the mixture of wine-stone and quicksilver, and will directly gild it, and you do not quench the gilding in water, but it will become cool by itself, you polish it as above mentioned, and will colour it in the same manner.

CHAPTER LXXII.

OF PIERCED WORK.

THIN out plates from the same copper as above, but thicker; these being designed, sculp whatever work you may wish, as above. You then have thin and wide instruments, according to the size of the grounds, which must be at one extremity thin and sharp, at the other blunt, which are called *meizil;* and placing the plate upon the anvil, you will perforate all the grounds with the above mentioned instruments, striking with the hammer. And when all the grounds have been perforated in such manner, you will smooth them all over with very small files down to the designs. Which being done you will gild it, and you polish the plate as above. Tablets are made in the same manner, and silver plates upon books, with figures, flowers, animals and birds, of which a part is gilt, namely the crowns of figures, and hair, and garments, in places, and part remains silver. Copper plates are also made, and they are carved and blackened and scraped; they are then placed in a vessel with melted tin, that the scrapings may become white, as if they were silvered. With these, painted chairs and seats, and beds are bound; the books of the poor are also (thus) ornamented.

CAPUT LXXIII.

DE OPERE PUNCTILI.

FIUNT etiam laminæ de cupro, modo quo superius, et fodiuntur gracili opere imaginum, florum sive bestiarum, et ita disponitur opus, ut campi parvuli sint, deinde purgantur cum subtili sabulo, et cum ferris ad hoc opus aptis poliuntur et colorantur. Post hæc ferro punctorio punguntur, quod hoc modo formatur. Ex chalybe fit ferrum ad mensuram digiti longum, in una summitate gracile, in altera grossius. Quod cum in graciliori parte æqualiter limatum fuerit, cum subtilissimo ferro et malleolo percutitur in medio ejus subtile foramen, deinde circa ipsum foramen diligenter limatur, donec ora ejus in circuitu æqualiter acuta fiat, ita ut quocunque percutiatur brevissimus circulus appareat. Post hæc ipsum ferrum modice calefactum, ut vix candescat, temperetur in aqua. Deinde tene ipsum ferrum sinistrâ manu et malleolum dextrâ, sedeatque puer ante te qui laminam teneat super incudem, et aptet in locis suis in quibus percussurus es, sicque mediocriter percutiens super ferrum cum malleolo imple campum unum subtilissimis circulis quanto propius possis conjungere unum alteri. Impletis campis omnibus in hunc modum pone ipsam laminam super prunas candentes, usque percussiones illæ fulvum colorem recipiant.

CAPUT LXXIV.

DE OPERE DUCTILI.

PERCUTE tabulam auream sive argenteam quantæ longitudinis et latitudinis velis ad elevandas imagines. Quod aurum vel argentum, cum primo fuderis, diligenter circumradendo vel fodiendo inspice, ne forte aliqua vesica sive fis-

CHAPTER LXXIII.

OF PUNCHED WORK.

Plates are also made from copper in the above manner, and are carved with delicate work of figures, flowers, or animals, and the work is so disposed that the grounds may be small, they are then cleaned with fine sand and are polished and coloured with instruments proper for this work. They are afterwards punched with the punching instrument, which is formed in this manner. An instrument is made from steel, long as the measure of a finger, fine at one extremity, at the other, thicker. When this has been smoothly filed at the finer end, a small hole is struck in the middle of it with a very fine instrument and small hammer; this hole is then carefully filed round until its rim become equally sharp around, so that a very small circle may appear wherever it may be struck. This instrument slightly warmed afterwards, so that it scarcely glows, is tempered in water. Then hold this iron in the left hand and the small hammer in the right, and let the boy sit before you, who can hold the plate upon the anvil and adjust it in the places in which you are about to strike, and thus fill up a ground with very fine circles as closely as you can join one to another, gently striking upon the iron with the small hammer. All the grounds being filled in, in this manner, place the plate itself upon the hot embers, until these beatings take a yellow colour.

CHAPTER LXXIV.

OF BEATEN WORK.

Beat a gold or silver plate as long and wide as you wish for relieving the figures. Which gold or silver, when you have first melted it, carefully examine by scraping or carving around it lest perchance any bubble or fissure may exist in it, which

sura in eo sit, quæ sæpe contingunt ex incuria, sive negligentia vel ignorantia aut inscitia fundentis, cum aut nimis calidum, aut nimis frigidum, aut nimis festinato, aut nimis productim effunditur. Cumque consideratè et cautè fuderis, si hujusmodi vitium in eo deprehenderis, cum ferro ad hoc apto diligenter effodies, si possis. Quod si tantæ profunditatis vesica sive fissura fuerit, ut effodere non possis, rursumque oportebit te fundere, et tamdiu donec sanum sit. Quod cum fuerit, provide, ut incudes et mallei tui omnino æquales et politi sint, cum quibus operari debes, et omni diligentia procura, ut tabula aurea vel argentea ita æqualiter ex omni parte attenuetur, ut in nullo loco spissius sit quam in alio. Cumque sic attenuata fuerit ut unguis vix inpressus appareat ex altera parte, et omnino sanissima, statim pertrahe imagines quod volueris, secundum libitos tuos. Pertrahes autem in ea parte, quæ sanior et decorior videtur, leniter tamen et sic ut ex altera parte modice appareat. Deinde cum ferro curvo bene polito fricabis leniter caput imprimis, quod altius debet esse; sicque convertens tabulam in recta parte fricabis circa caput et cum ferro æquali et polito, ita ut campus descendat et caput elevetur, et statim circa caput cum malleo mediocri super incudem percuties leniter, sicque coram fornace superpositis carbonibus in ipso loco recoques, donec candescat. Quo facto et tabula per se refrigerata, iterum in inferiore parte cum curvo ferro fricabis leniter et diligenter fossam capitis interius, convertensque tabulam in superiori parte denuo cum æquali ferro fricabis, et depones campum ut monticulus elevetur capitis, rursumque cum malleo mediocri circa ipsum leniter percutiens, appositis carbonibus recoques; sicque sæpe facies, diligenter elevando interius et exterius, et crebro percutiendo, totiensque recoquendo donec monticulus ille ducatur ad altitudinem trium digitorum aut quatuor, sive plus vel minus secundum quantitatem imaginum. Si autem ipsum aurum vel argentum adhuc aliquantum spissius est,

things often happen through carelessness or negligence, or ignorance or unskilfulness of the founder, when it is cast either too hot or too cold, or in too great haste, or too slowly. When you have considerately and cautiously cast it, should you perceive a fault of this kind in it, carefully sculp it out with the instrument fit for this work, if you can. But should the bubble or fissure be of such depth that you cannot dig it out, you must again melt it, and so until it is become sound. When it has become so, see beforehand that the anvils and your hammers, with which you should work, are quite smooth and polished; and take care that the gold or silver plate be so equally thinned everywhere, that it be in no place thicker than in another. And when it has been thinned so that the nail, slightly pressed upon it, may show upon the other side, and it is perfectly sound, directly portray the figures you may wish, according to your will. You design, also, in that part which is seen to be the most sound and beautiful, gently however, and so that it may slightly appear on the other side. You will then with a curved iron, well polished, gently rub the head, in the first place, which must be more raised; and so turning the plate upon the right side you will rub around the head, also with the smooth and polished iron, so that the ground may descend and the head be raised, and you directly beat around the head with a middling sized hammer upon the anvil, gently, and you thus cook it before the furnace, until it glows, coals being superposed in that place. Which being done, and the plate cooled by itself, you will again rub it with the curved instrument on the underneath part, inside the hollow of the head, slightly and carefully, and turning the plate you will again rub with the smooth iron upon the upper part, and you depress the ground that the relief of the head may be raised, and again gently striking it with the middling hammer about this, you recook it, by applying the coals; and thus you act often, by carefully raising it inside and outside and frequently hammering, as often cooking until the relief is brought to the height of three or four fingers, or more or less, according to the number of the figures. If, however, the gold or silver is yet somewhat too thick, you

poteris interius cum longo malleo et gracili percutere et attenuare, si opus fuerit. Quod si duo capita, vel tria seu plura in tabula esse debeant, circa unumquodque ita facere debes sicut dixi, usque ad altitudinem quantam volueris. Deinde cum pertractorio ferro designa corpus vel corpora imaginum, et ita deducendo et interdum percutiendo, elevabis ea quantum libuerit; hoc tamen procurans ut caput semper sit altius. Post hæc designabis nares et oculorum supercilia, os et aures, capillos, oculos, manus et brachia, cæterasque vestimentorum umbras, scabella et pedes, et sic interius cum minoribus curvis ferris elevabis leniter et diligenter, summopere cavens ut non rumpatur aut perforetur. Quod si ex ignorantia seu negligentia contigerit, hoc modo solidari debet. Tolle ipsius auri vel argenti modicum, et admisce tertiam partem cupri, fundensque pariter limabis subtiliter, combustoque viniceo lapide, et addito sale commiscebis aqua, ex quo tenuiter liniens, fracturam supersparge limaturam. Qua siccata denuo confectionem superlinies spissius, et sic inferius et superius admotis carbonibus leniter flabis, donec videas solidaturam deffluere. Quod videns statim asperge leniter aquâ, et si firmum fuerit, bene; sin autem, denuo similiter fac usque dum firmum fuerit. Si autem fractura lata fuerit, diligenter conjunge ei particulam ejusdem auri vel argenti æqualiter tenuem, quam simili modo solidabis, donec ex omni parte adhæreat. Cumque elevatura imaginum perducta fuerit usque ad subtiles tractus, si aurum fuerit, statim facies eos et polies diligenter, atque colorabis cum atramento usque ad ruborem combusto, et sale, ut supra in opere calicis. Si vero argentea fuerit tabula, et volueris in ipsis imaginibus deaurare coronas, capillos, barbas, et partes vestimentorum, hoc oportet fieri prius—quam subtiles tractus fiant, hoc modo. Compone duas partes argillæ simplices, subtiliter tritæ, et tertiam salis, et in vasculo commisce cum fece cervisiæ mediocriter spissæ, quâ confectione

can beat and thin it with a long and slender hammer, if needful. But if two or three, or more, heads should be in the picture, you should do about each one as I have said, until the height which you may wish is attained. Then with the tracing instrument design the body or bodies of the figures, and so, by depressing and sometimes by beating, you will relieve them as much as it may please you; providing this, however, that the head be always the most relieved. After these things you will design the nostrils and eyebrows, the mouth and ears, the hair, eyes, hands and arms, and the other shadows of the draperies, the footstools and feet, and you will raise them inside thus, with the smallest curved instruments, above all taking care that it be not broken or perforated. But if through want of knowledge, or negligence, this should happen, it should be soldered in this manner. Take a little of the gold itself, or silver, and mix with it a third part of copper, and melting them together you will file it finely, and wine-stone being burnt and salt added, you will mix it with water; thinly anointing it with which, spread the filing over the fracture. This dry, again anoint the mixture, more thickly, and coals being applied above and below, you will blow gently, until you can see the solder flow. Seeing which, immediately sprinkle it with water, and if it be hard, well; if not, however, do the like again until it has become firm. Should the fracture, however, be broad, carefully join a small piece of the same gold or silver, equally thin, to it, which you will solder in the like manner until it adhere everywhere. And when the relief of the figures shall have been carried to the point of the chasings, should it be gold, you immediately make them, and polish carefully, and you will colour it with "atrament,"[1] burnt to redness, and salt, as above in the work of the chalice. Should, however, the picture be silver, and you should wish upon these figures to gild the crowns, the hair, beard and portions of the draperies, this should be done before the fine lines are made, in this manner. Arrange two parts only of clay, finely ground, and a third of salt, and mix them together in a small vessel with

[1] *"green vitriol", or sulphate of iron. Trans. see note.*

cooperies omne argentum quod volueris ut album remaneat, et quod deaurandum est, maneat intectum. Quod cum siccaveris super prunas, deaurabis loca singula diligenter sine aqua, deaurataque lavabis[1] et polita incolorabis. Deinde cum carbonibus subtiliter tritis et lignis gracilioribus et grossioribus fricabis diligenter, usque per omnia æque clarum sit. Post hæc et in auro et in argento fac subtiles tractus, quos et faciendo pariter polies, donec ad perfectionem perducas. Cum vero tabulas illas aureas vel argenteas pleniter elevatas atque politas configere volueris, tolle ceram et liquefac in vase fictili vel cupreo, atque commisce ei tegulam subtiliter tritam sive sabulum, ita ut sint hujus duæ partes et ceræ tertia. Quod cum pariter liquefactum fuerit, cum cochleari ligneo fortiter commovebis, et inde implebis omnes imagines in auro, argento, sive cupro, vel quodcunque in his elevatum fuerit, et refrigeratum confige ubi velis. In cupreis vero tabulis eodem modo attenuatis simile opus fit, sed majori virium instantiâ et diligentiâ, quam durioris naturæ est. Quod opus cum pervenerit ed subtiles tractus, debet in exteriori parte purgari cum laneo panno et sabulo, donec nigra cutis auferatur, et sic deaurari atque poliri, perfectisque decolorari[2] tractibus, et prædictis confectionibus impleri.

CAPUT LXXV.

DE OPERE QUOD SIGILLIS INPRIMITUR.

FIANT etiam ferri ad mensuram unius digiti spissi, tribus digitis vel quatuor lati, longitudine[3] unius, qui sanissimi debent esse, ut in eis nulla sit macula, nulla fissura in superiori latere. In his sculpantur in similitudine sigillorum

[1] *vitiosè* "levabis," *in Cod. Harl.*
[2] "incolorari," *in Cod. Guelph.*
[3] *erbum* "pedis," *in Cod. Guelph. invenitur.*

the dregs of beer, moderately thick, with which mixture you cover all the silver which you may wish should remain white, and that which is to be gilt can remain bare. When you shall have dried this over the embers, you will gild the places one by one without water, being gilt, you will wash it, and polished, you will colour it. Then with finely pulverized charcoal, and with pieces of wood, larger and smaller, you will rub it carefully until it be equally bright everywhere. You afterwards make the fine lines, both on the gold and on the silver, which in the making you likewise polish, until you bring it to perfection. When you wish to affix these gold or silver plates fully relieved and polished, take wax and melt it in an earthenware or copper vessel, and mix tile, finely ground, with it, or sand, so that there may be two parts of this and a third of wax. When this has been likewise melted, you will strongly stir it with a wooden spoon, and fill up all the figures with it in gold, silver, or copper, or whatever may have been relieved in these, and cold, you will attach it where you wish. Also in copper plates, thinned in the same manner, the like work is made, but with greater attention and care as to strength, as its nature is more hard. When this work has been brought to the fine lines, it should be cleaned on the outside part with a woollen cloth and sand, until the black coat be taken off, and so be gilt and polished, and the drawings being finished, be coloured and filled with the above mentioned composition.

CHAPTER LXXV.

OF WORK WHICH IS IMPRESSED WITH STAMPS.

Irons are also made, thick as the size of a finger, wide as three or four fingers, in length one (foot[1]), which should be sound, that no blemish may exist in them, no fissure in the upper side. In these are sculptured, in resemblance of seals,

[1] This word is wanting in the Harleian MS., it is supplied from the Wolfenbüttel MS.

limbi graciles et latiores, in quibus sint flores, bestiæ et aviculæ, sive dracones concatenati collis et caudis, et non sculpantur profundè nimis, sed mediocriter ac studiosè. Deinde attenuabis argentum multo tenuius quam ad elevandum quantæ longitudinis volueris, atque purgabis cum carbonibus subtiliter tritis, et panno, polies cum creta desuper rasâ. Quo facto conjunge argentum cuicunque limbo, suppositoque ferro incudem, ita ut sculptura superius sit, ac superlocato ei argento, desuper pone plumbum (spissum[1], percutiesque cum maleo fortiter, ita ut plumbum) impingat argentum tenue in sculpturam tam validè, ut omnes tractus in eo pleniter appareant. Quod si lamina longior fuerit, trahe eam de loco ad locum, et conjunctam ferro cum forcipe æqualiter tene, ut una parte percussâ, alia percutiatur, sicque fiat donec lamina tota impleatur. Hoc opus satis utile est circa limbos in fabricandis tabulis altarium, in pulpitibus, in sanctorum corporum scriniis, in libris et in quibuscunque locis opus fuerit, quando elevatura decora est et subtilis, et leviter fit. Fit etiam in cupro hujusmodi quod simili modo attenuatur, purgatur et deauratur atque politur; quod ferro superpositum, ita ut deauratura vertatur ad ferrum, plumbo superposito percutitur donec tractus appareant. Sculpitur quoque in ferro, modo supradicto, imago crucifixi Domini, quæ cum argento vel cupro deaurato inpingitur, et fabricantur inde phylacteria, id est capsellæ reliquiarum et scriniola Sanctorum. Fit etiam sculptura imaginis Agni Dei in ferro, et imagines quatuor evangelistarum, quibus auro vel argento impressis ornantur scyphi ligni pretiosi, stante rotula agni in medio scyphi, quatuor evangelistis in modum crucis in circuitu, et procedentibus quatuor limbis ab agno usque ad quatuor evangelistas: fiunt imagines pisciculorum et avium atque bestiarum, quæ figuntur per reliquum scyphi campum, præbentes ornatum multum. Fit etiam imago Majestatis eodem modo, aliæque imagines, cujuscun-

[1] *addidimus, ex Cod. Guelph.*

borders slender and wide, in which can be flowers, animals and small birds, or dragons linked together by the necks and tails, and they are not sculptured too deeply, but moderately and carefully. You will then thin silver, much more thinly than for the relief, of the length you wish, and you will cleanse it with charcoal, finely pulverized, and a cloth; you polish it with chalk scraped upon it.

Which being done, affix the silver to any border, and the iron being placed upon an anvil, so that the engraving may be uppermost, and the silver lying upon it, place above it some thick lead and strike strongly with the hammer, so that the lead may beat upon the thin silver, into the sculpture, so strongly, that all the designs may fully appear in it. But should the plate be longer (than the stamp) draw it from place to place, and, affixed to the iron, hold it evenly with the pincers, and one part being struck, another can be hammered, and do thus until all the plate be filled up. This kind of work is rather useful, about the borders, in manufacturing the tables of altars, in pulpits, in caskets for sacred substances, and in whatever places needful; and when the relief is beautiful and delicate, it is easily done. Work of this kind is also made in copper, which is thinned in a similar manner, is cleansed and gilt and polished; this placed upon the iron, so that the gilding be turned towards the iron, the lead being superposed, it is struck until the designs appear. The image of the crucifixion of the Lord is also sculptured in iron, in the above mentioned manner, of which, when impressed upon silver or copper, phylacteria are made, that is, coffers of relics and small shrines of saints. A sculpture is also made in iron of the image of the Lamb of God, and the figures of the four evangelists, with which, impressed upon gold or silver, the cups of precious wood are ornamented, the circle of the lamb standing in the middle of the cup, the four evangelists in fashion of a cross around, and with four borders proceeding from the lamb to the four evangelists; figures of small fish and of birds and beasts are made, which are fixed upon the remaining ground of the cup, affording much ornament. The image of the Divinity is also made in the same manner,

que formæ et sexus, quæ impressæ auro vel argento seu cupro deaurato, plurimum decoris præstant locis, quibus inponuntur, propter subtilitatem et operositatem. Fiunt et imagines regum et equitum eodem modo ferro, ex quibus auricalco Hispanico inpressis ornantur pelves, quibus aqua in manibus funditur, eodem modo quo ornantur scyphi auro vel argento, cum suis limbis ejusdem metalli, in quibus bestiolæ vel aves et flosculi, qui tamen non configuntur, sed stagno solidantur.

CAPUT LXXVI.

DE CLAVIS.

FIUNT autem clavi ferrei longitudine unius digiti, in una summitate grossiores, in altera graciliores, in qua etiam chalybe solidandi sunt, quorum unus limetur quadrangulus, alius triangulus, tertius rotundus, secundum convenientem grossitudinem. Deinde sculpantur in eis flosculi eodem modo, quo supra, ita ut ora ferri circa flosculum acuta fiat. Cumque valdè attenuatum fuerit argentum sive cuprum deauratum, vel auricalcum, in superiori parte polies, ut supra; in inferiori vero superstagnabis valdè tenuè cum ferro, quo fenestræ solidantur, ponesque plumbum spissum super incudem et desuper argentum, sive cuprum deauratum, ita ut deauratura superius sit et stagnum inferius; sumptoque uno ex ferris, quale velis, junge sculpturam ad argentum, percutiesque malleo ita ut sculptura in eo appareat, et cum acuta ora ferri in circuitu incidatur. Quod cum per totum argentum feceris, serva tibi flosculos omnes, quia illi erunt capita clavorum, quorum caudas hoc modo facies. Commisce duas partes stagni, et tertiam plumbi, et percute illud gracile et longum, deinde pertrahe per foramina ferri, in quo fila trahuntur, ita ut longissimum filum habeat, et non gracile nimis, sed me-

and other figures of any form or sex, which being impressed upon gold or silver, or gilt copper, give the greatest ornament to the places upon which they are placed, on account of their fineness and labour. The figures of kings and knights are also made in the same manner in iron, with which, impressed upon Spanish brass, the basins, from which water is poured upon the hands, are ornamented in the same manner in which cups are embellished, with gold or silver, with their borders of the same metal, in which are small animals or birds and flowers, which, however, are not fixed together, but are soldered with tin.

CHAPTER LXXVI.

OF NAILS.

Iron nails are made the length of a finger, thicker at one end, more pointed at the other, in which also they are to be made strong with steel, of which one is filed square, another triangular, a third round, according to the size convenient. Small flowers are then sculptured upon them in the same manner as above, so that the rim of the iron around the flower may become sharp. And when silver, or gilt copper, or brass, has been well thinned, you polish it upon the upper surface as above; but on the lower you will tin it over very thinly, with the iron with which windows are soldered, and you place thick lead upon the anvil and the silver or gilt copper upon it, so that the gilding may be upwards and the tin below; and one of the irons being taken, whichever you may wish, apply the sculpture to the silver, and strike with the hammer, so that the sculpture may appear upon it, and it may be cut around with the sharp rim of the iron. When you have done this through all the silver, keep all the small flowers by you, because they will be the heads of the nails, the stems of which you make in this manner. Mix together two parts of tin and a third of lead, and beat it out thin and long, then draw it through the openings of the instrument, in which wires are drawn, so that it may have a long thread,

diocre. Post hæc fac tibi ferrum gracile, longitudine dimidii pedis, quod in una summitate sit modice latum, ad mensuram unguis, et mediocriter cavum, et altera summitas infigatur ligneo manubrio. Deinde sedens juxta fornacem ad hoc opus aptam, ante quam stet vasculum cupreum cum cera liquefacta, tenensque sinistra manu manubrium illius gracilis ferri in latiori parte calefactum, in dextra vero stagneum filum, quasi globum involutum cujus caput facies in cera liquefacta humidum, ponensque super unum ex flosculis, eâ parte ubi stagnum est, ita ut adhæreat, levabis, et pones in fossulam ferri candentis, tenebisque donec liquefiat, statimque removebis utrumque ab igne, incidesque filum cum forcipe secundum longitudinem quam vis habere caudam clavi. Sicque facies donec expendas in hujusmodi clavis argentum illud cuprumque deauratum. Cumque clavorum copiam habueris, et eos configere volueris in corrigiis ascensoriis sellæ equi, sive circa capitium freni, primum cum subula fac foramina, et sic impone clavos ordinatim, ita ut sint tres aurei et tres argentei, rursumque tres aurei, et smili modo per totum. Si vero duos ordines vel tres habere volueris, pone semper unum argenteum et alterum aureum per omnia, sicque ponens corrigiam cum captibus super tabulam ligneam æqualem, confige caudas cum mediocri malleo. Fiunt etiam eodem opere clavi ex auricalco, sed spissiores, quorum caudæ cupreæ solidantur interius stagno puro eodem modo. His configuntur vaginæ cultellorum, et coria super libros, multaque hujusmodi.

CAPUT LXXVII.

DE SOLIDANDO AURO ET ARGENTO PARITER.

PURIFICATURUM argentum pondere duodecim nummorum, percutitur strictim longitudine dimidii digiti

and not too slender, but middling. After this make for yourself a thin iron half a foot in length, which must be rather wide at one extremity, to the size of your nail, and slightly hollow, and the other end can be fixed to a wooden handle. Then sitting near the furnace proper for this work, before which a small copper vessel with melted wax can stand, and in the left hand holding the handle of this thin iron, made hot in the wider part, and in the right the tin wire, the extremity of which rolled like a ball, you moisten in the melted wax, and placing it upon one of the flowers in that part where the tin is, so that it may adhere, you will raise it, and you place it in the hollow of the heated iron and will hold it until it liquefy, and you will instantly remove both from the fire and you cut the wire with the forceps according to the length which you wish the stem of the nail to possess. And you do thus until you expend, in nails of this kind, that silver and gilt copper. And when you have an abundance of nails, and may wish to fix them upon the stirrup leathers of a horse-saddle, or about the head-piece of a bridle, first make holes with the awl, and so place the nails in order, so that three may be golden and three silver, and again three gold, and similarly throughout. But should you wish to have two or three rows, always place one silver and the other golden throughout, and so placing the strap with the heads upon a smooth wooden table, fasten on the stems with a middle sized hammer. Nails are also made by the same workmanship from brass, but thicker, the copper stems of which are soldered inside with pure tin in the same manner. With these the sheaths of knives are fixed, and leathers upon books, and many things of this kind.

CHAPTER LXXVII.

OF SOLDERING GOLD AND SILVER TOGETHER.

Silver of the weight of twelve nummi having been purified is beaten straightly to the length of half the little finger, pre-

minoris, deinde percutitur aurum coctum pondere unius nummi eadem latitudine et longitudine, atque consolidantur hæc duo præscriptâ solidaturâ auri, donec omnino sibi adhæreant, sicque simul percutiantur usque dum tenuissima lamina fiat. Hoc opus videtur, quasi argentum in una parte deauratum sit, nec possit cum duobus aut tribus nummis auri tantæ longitudinis lamina tam fulgide deaurari. Ex hac lamina fiunt limbi, modo quo superius inpressi ferri. Inde etiam inciduntur subtiles corrigiæ, et in serico filando circumtorquentur, unde texuntur aurifrigia apud pauperes eodem modo quo apud divites ex auro puro.

CAPUT LXXVIII.

DE OPERE DUCTILI QUOD SCULPITUR.

PERCUTE tabulam cupream quantæ longitudinis et latitudinis volueris, sic spissam ut vix plicari possit, et sit sanissima ab omni fissura et macula, et pertrahe in ea imaginem, quam volueris. Deinde percute in loco capitis fossam cum mediocri malleo[1] in circuitu, sicque recoques in prunis. Qua refrigerata per se, facies per totam imaginem cum malleis sicut fecisti in tenui cupro cum curvis ferris et æqualibus, semper ex utraque parte deducendo et frequenter recoquendo. Cumque elevaveris imaginem quam altè volueris, accipe ferros ad mensuram palmi longos, in una summitate grossiores, super quos possit cum malleo percuti, et in altera graciliores, tenues, rotundos atque subtiles, quos ad hoc opus aptaveris, et sedente coram te puero hujus artis docto, tene sinistrâ manu tabulam et dexterâ ferros, puero desuper feriente cum mediocri malleo, designabis oculos et nares, capillos et manuum digitos, pedum articulos, et omnes tractus vestimentorum in superiori parte, ita ut interius appareant, ubi etiam

[1] "Rotundo in inferiori parte, et ex superiori parte cum tenui malleo."—*Ex. Codice Guelpherbytano.*

pared gold of the weight of a nummus is then beaten to the same breadth and length, and these two are united together with the prescribed gold solder, until they perfectly adhere to each other, and they are thus beaten together until a very fine plate is made. This work appears as if the silver were gilt on one side; nor can a leaf of such length be so brilliantly gilt with two or three nummi of gold. From this leaf borders are made, from the iron stamp, in the before-mentioned manner. Fine strips are also cut from it and are wreathed round in spun silk; gold fringes are made from it for the poor in the same manner as from pure gold for the rich.

CHAPTER LXXVIII.

OF BEATEN WORK WHICH IS SCULPTURED.

Beat a copper plate as long and wide as you wish, so thick that it can scarcely be bent, and let it be sound, free from all crack and blemish, and portray the figure upon it which you may wish. Then beat the cavity in the place of the head with a moderate round hammer on the under side, and around it, on the upper side, with the slender hammer, and so you cook it in the embers. This being cooled by itself, you will do throughout the whole figure with the hammer as you did in the thin copper with the curved and smooth irons, by always depressing it on each side and frequently reheating it. And when you shall have relieved the figure as high as you wish, take irons, long to the measure of a palm, thicker at one end, upon which it may be beaten with the hammer, and at the other more fine, round, and pointed, which you had prepared for this work, and the boy initiated in this art sitting before you, hold the plate in the left hand and the irons in the right, the boy striking upon them with a moderate sized hammer, you will design the eyes and nostrils, the hair and fingers of the hands, the articulations of the feet, and all the drawings of the garments upon the upper side, so that they may show inside,

cum eisdem ferris percuties, ut (exterius eleventur tractus[1]). Quod cum tam diu feceris donec imago omnino formetur, cum ferris fossoriis et rasoriis fodies circa oculos et nares, os et mentum et aures, designabisque capillos et omnes subtiles vestimentorum tractus, et ungues manuum et pedum. Quo facto, si volueris coronas imaginum ornare gemmis, electro atque margaritis, statim operare singulas partes in auro cum filis et solidaturâ, sicut superius in opere calicis, et adjungens unamquamque loco suo, fac foramina, per quæ configi debent, videlicet sub majoribus gemmis, et in cupro æqualiter; sicque deaurabis tabulam et polies eam in primis cum filis ex auricalco sicut supra, deinde cum ferris æqualibus; sicque colorabis et configes auri partes unamquamque in suo loco, imponesque gemmas et circumligabis margaritas.

Eodem modo, si facultas in censu[2] fuerit, potes in auro et argento facere imagines super libros evangeliorum et missales, et bestias atque aviculas ac flores super sellas equestres matronarum exterius. Fiunt eodem modo, in scyphis aureis sive argenties vel scutellis, in medio, equites contra dracones sive leones vel gryphes pugnantes, imago Samsonis vel David ora leonum confringentes; leones quoque simplices et gryphes, idem etiam singuli singulas pecudes suffocantes, sive aliud quod libuerit, quodque secundum operis quantitatem decens vel aptum fuerit.

CAPUT LXXIX.

DE PURGANDA ANTIQUA DEAURATURA.

TOLLE smigma et pone in pelve, sive alio vase mundo, superfundens ei aquam mundam atque diligenter commisce usque sit spissum ut fex, ita ut ubicumque superponatur non possit fluere. Deinde cum setis porci linies hanc di-

[1] *lacuna est, in Cod. Harl. in hoc loco: implevimus ex Cod. Guelph.*
[2] *imò* "sensu."

where also you strike with the same irons that the designs may be raised outside. When you have done this until the figure be altogether formed, you sculp with the sculping and scraping instruments about the eyes and nostrils, the mouth and chin and ears, and you will design the hair and all the fine drawing of the draperies, and the nails of the hands and feet. Which being done, if you wish to decorate the crowns of the figures with gems, enamel, and pearls, immediately work single pieces in gold with wires and solder, as above in the work of the chalice, and fitting each one in its place, make holes through which they should be fastened on, namely, under the larger gems, and equally in the copper; and you will thus gild the plate, and you polish it at first with the brass wires, as above, then with the smooth irons; and thus you will colour it, and you fix on the pieces of gold, each one in its place, and you lay on the gems, and you will fasten the pearls around. In the same manner should you possess facility of invention, you can make figures in gold and silver upon the books of the evangelists and missals, and animals and small birds and flowers outside upon the horse-saddles of matrons. Upon golden or silver cups or platters, in the middle, knights are made in the same manner, fighting against lions or griffins; the figure of Sampson, or David breaking the mouths of the lions; lions alone, also, and griffins; the same also, each strangling single (figures of) cattle; or other thing which it may please you, and which may be proper and fit, according to the size of the work.

CHAPTER LXXIX.

OF CLEANING OLD GILDING.

Take soap and place it in a basin, or other clean vessel, pouring clean water upon it, carefully mix it together, until it be as thick as lees, so that it cannot flow wheresoever it may be placed. Then with hogs' bristles anoint this carefully over

ligenter super vetustam deauraturam in cupro sive argento, quæ fulgorem suum perdiderit, sic ut omnino cooperiatur, et sines ita manere per noctem. Secunda vero die aquâ lavabis cum eisdem setis semel et iterum, atque tertio perfundes limpida aqua, videbisque eam fulgere sicut placuerit oculis tuis.

CAPUT LXXX.

DE PURGANDO AURO ET ARGENTO.

SI aurum et argentum laminis attenuatum atque clavis alicubi confixum denigratum vetustate fuerit, tolle carbones nigros et minutissime tere eos atque per pannum cribra, sumensque pannum lineum sive laneum aquâ madefactum, pones super ipsos carbones, elevansque fricabis diligenter per omnia aurum vel argentum, donec omnem nigredinem auferas, sicque lavabis aquâ, et sole sive igne vel panno siccabis; deinde tolle cretam candidam, et minutissime rade in vase, et cum lineo panno ita siccam fricabis super aurum vel argentum tamdiu, donec pristinum fulgorem recipiat. Eodem modo purgantur vasa.

CAPUT LXXXI.

DE ORGANIS.

FACTURUS organa primum habeat lectionem mensuræ, qualiter metiri debeant fistulæ graves et acutæ et superacutæ; deinde faciat sibi ferrum longum et grossum ad mensuram, qua vult habere fistulas, quod sit in circuitu, rotundum summâ diligentiâ limatum et politum, in una summitate grossius et modice attenuatum, ita ut possit inponi in alterum fer-

the old gilding in copper or silver, which may have lost its brightness, so that it may be entirely covered, and you allow it so to remain for a night. But on the second day you will wash it in water with the same bristles once and again, and on the third time pour clear water over it, and you will see it shine so as to gratify your eyes.

CHAPTER LXXX.

OF CLEANSING GOLD AND SILVER.

If gold and silver, thinned into leaves and fixed anywhere by nails, has become blackened through age, take black charcoal and grind it very small and sift it through a cloth, and taking a linen or woollen cloth wetted with water, place it upon these coals, and raising it you will rub it carefully over all the gold or silver, until you take away all the blackness, and thus you will wash it with water, and will dry it in the sun, or by the fire, or with a cloth; then take white chalk, and scrape it very finely into a vessel, and thus you will rub it dry with a linen cloth upon the gold or silver until it take its original lustre. Vases are cleaned in the same manner.

CHAPTER LXXXI.

OF ORGANS.

The manufacturer of organs should first possess the knowledge of the measure, how the grave and sharp and treble pipes should be meted out; he may then make for himself a long and thick iron to the size which he wishes the pipes to possess; this must be round, filed and polished with great care, thicker at one extremity and slightly diminished, so that

rum curvum per quod circumdatur, juxta modum ligni in quo volvitur runcina, et in altera summitate gracile, secundum mensuram inferioris capitis fistulæ, qua conflatorio debet imponi. Deinde attenuetur cuprum purum et sanissimum, ita ut unguis impressus alterâ parte appareat. Quod cum fuerit secundum mensuram ferri lineatum et incisum ad longiores fistulas, quæ dicuntur graves, fiat secundum præceptum lectionis foramen, in quo plectrum imponi debet, et circumradatur modicè ad mensuram festucæ [1], ac superliniatur stagnum ferro solidatorio, radaturque in ora longitudinis interius, in altera ora exterius eadem mensura, et superstagnetur tenuè. Quæ stagnatura, priusquam rasi tractus noviter facti, modicè calefacto cupro lineantur cum resina abietis, ut stagnum facilius adhæreat. Quo facto complicetur ipsum cuprum circa ferrum et circumligetur filo ferreo mediocriter grosso fortiter, ita ut stagnati tractus conveniant sibi. Quod filum primo induci debet parvulo foramini, quod est in gracili summitate ferri, et in eo bis contorqueri, sicque deduci in volvendo usque ad alteram summitatem, ibique similiter obfirmari. Deinde juncturis sibi convenientibus et diligenter conjunctis, ponatur ipsâ ligaturâ pariter cum ferro ante fornacem super prunas ardentes, et sedente puero et mediocriter flante, teneatur dexterâ manu lignum gracile, in cujus summitate fissa, adhæreat panniculus cum resina, et sinistrâ teneatur stagnum longum gracile percussum, ut mox cum fistula incaluerit, lineat juncturam cum panniculo resina infecto, appositumque stagnum liquefiat, ipsamque juncturam [2] diligenter consolidet. Quo factore frigerata fistula, ponatur ferrum in instrumento tornatoris more parato, in posito que curvo ferro et filo soluto circum volvat unus ferrum curvum, alter vero, utrisque manibus chirothecis [3] indutis, fistulam fortiter teneat, ita ut ferrum circumducatur et fistula quieta

[1] "fistulæ," *in Cod. Guelph.*
[2] *addidimus ex Cod. Guelph.*
[3] *Hic codex* "cyrotecis" *habet.*

it can be placed in another curved iron, by which it is encompassed, after the fashion of the wood in which the auger is revolved, and at the other extremity let it be slender, according to the size of the lower end of the pipe which should be placed on the bellows. Then pure and very sound copper is thinned, so that the impression of the nail may appear on the other side. When this has been marked out and cut according to the size of the iron for the longer pipes, which are called grave, an opening is made according to the precept of the lesson, into which the valve should be placed, and it is rasped round a little to the size of the rod [1], and tin is anointed over it with the soldering iron, and it is rasped upon one edge of the length inside, and outside, upon the other edge, and it is tinned over thinly. Which tinnings, before the newly made lines are scraped, are slightly anointed, the copper being warmed with resin of the fir, that the tin may the more easily adhere. Which being done this copper is folded around the iron and is strongly bound round with an iron wire moderately thick, so that the tinned lines may agree with each other. This wire should be first carried through a very small hole which is at the thin extremity of the iron, and be twisted twice round in it, and so be carried down revolving to the other extremity, and be there similarly fastened. Then with its joinings agreeing together and carefully fastened, it is placed with its ligature, as with the iron, before the furnace upon the glowing embers, and the boy sitting and slightly blowing, in the left hand is held a thin wood, at the split top of which a small cloth with resin is fixed, and in the right can be held a long piece of tin beaten thin, so that directly the pipe has become hot he can anoint the join with the rag filled with resin, and the tin applied may liquefy, and he must carefully solder the join together. Which being done, the pipe cold, the iron is placed in the instrument prepared like that of a turner, and the curved iron being placed on, and wire loosened, one (hand) can revolve the curved iron, the other, both hands being provided with gloves, can hold the pipe firmly, so that the iron may

[1] "pipe," in the Wolfenbüttel MS.

maneat, donec omnino oculis gratiosa sit, quasi tornata sit. Deinde educto ferro percutiatur ipsa fistula cum malleo mediocriter juxta foramen inferius et superius, ita ut pene usque ad medium descendat ipsa rotunditas spatio duorum digitorum; fiatque plectrum ex cupro aliquantulum spissiori, quasi dimidia rotula, et superstagnetur circa rotunditatem sicut fistula superius, sicque ponatur in inferiori parte foraminis, ut sub ipsius ora æqualiter stet, nec procedat inferius aut superius. Habeat quoque ferrum solidatorium ejusdem latitudinis et rotunditatis, qua plectrum est. Quo calefacto ponat modicas particulas stagni super plectrum, parumque resinæ, et diligenter circumducat calidum ferrum ne plectrum moveatur, sed liquefacto stagno sic adhæreat ut in circuitu ejus nichil spiraminis exeat, nisi tantum in superiori foramine. Quo facto apponat ori et sufflet primum modice, deinde amplius, sicque fortiter, et secundum quod auditu discernit, disponat vocem, ut si eam vult esse grossam, foramen fiat latius; si vero graciliorum, fiat strictius. Hoc ordine omnes fistulæ fiant; mensurem vero singularum, a plectro superius, secundum magisterium lectionis faciat, a plectro autem inferius, omnes unius mensuræ et ejusdem grossitudinis erunt.

CAPUT LXXXII.

DE DOMO ORGANARIA.

DOMUS vero facturus super quam statuendæ sint fistulæ, vide utrum volueris eam ligneam habere aut cupream. Si ligneam, acquire tibi duo ligna de platano, valde sicca, longitudine duorum pedum et dimidii, et latitudine modicè amplius quam unius, unum quatuor, alterum duobus digitis spissum, quæ non sint nodosa sed pura. Quibus diligentissimè sibi conjunctis, in inferiori parte spissioris ligni fiat in medio

be carried round and the pipe remain still, until it appear elegant to the eyes, as if turned. The iron being then taken out, the pipe is struck slightly with the hammer near the opening, above and below, so that this round shape may depress almost to the centre for a space of two fingers; the valve may be made from copper somewhat thicker, like a half wheel, and be soldered over about the round part, as the pipe above, and be so placed in the lower part of the opening that its edge may stand equally under it, nor protrude below or above. He can have also a soldering iron of the same breadth and roundness as is the valve. With this, heated, he can place small particles of tin upon the valve, and a little resin, and can carefully pass over the hot iron that he may not move the valve, but that the tin being melted it may so adhere that no wind can come out in its circumference, unless only into the upper opening. Which being done he can bring it to his mouth and blow at first slightly, then more, and then strongly; and according to what he discerns by hearing, he can arrange the sound, so that if he wish it strong, the opening is made wider; if slighter, however, it is made narrower. In this order all the pipes are made; he can make the measure of each, from the valve upwards, according to the rule inculcated, but from the valve below, all will be of one measure and of the same thickness[1].

CHAPTER LXXXII.

OF THE ORGAN ERECTION.

In the manufacture of the construction, upon which the pipes are to stand, see whether you intend to have it of wood or copper. If of wood, procure for yourself two pieces of wood of the plane tree, very dry, two feet and a half in length, and in breadth rather more than one; one four, the other two fingers thick, which must not be knotty, but without blemish. Which being carefully joined together, in the lower part of

[1] Here end the most voluminous of the MSS. of Theophilus hitherto known.

foramen quadrangulum, amplitudinè quatuor digitorum et circa quod reliquantur de eodem ligno limbus, unius digiti latitudinis et altitudinis, in quo conflatorium inponatur. In superiori parte verò lateris fiant cavaturæ, per quas flatus ad fistulas possit pervenire. Altera vero pars ligni, quæ et superiori esse debet, metiatur interius æqualiter, ubi disponantur septem vel octo cavaturæ, in quibus diligenter jungantur linguæ, ita ut habeant facilem cursum educendi et reducendi, sic tamen ut nichil spiraminis inter juncturas exeat.

In superiori autem parte tonde cavaturæ, contra inferiores, quæ sint aliquantulum latiores, in quibus jungantur totidem ligna, ita ut inter hæc et majus, ligni cavatura remaneat vacua, per ventus ascendat ad fistulas, nam in eisdem lignis foramina fieri debent, in quibus fistulæ stabiliendæ sunt. Cavaturæ in quibus linguæ junctæ sunt in anteriori parte, procedere debeant quasi obliquæ fenestræ, per quas ipsæ linguæ introducantur et extrahantur.

In posteriori vero parte, sub fine ipsarum linguarum, fiant foramina æqualiter lata et longa, mensura duorum digitorum, per quas ventus possit ascendere ab inferioribus ad superiora, ita ut cum linguæ impinguntur, illa foramina ab eis obstruantur, cum vero trahuntur denuò pateant. In his vero lignis quæ super linguas junguntur fiant foramina diligenter et ordinatè, secundum numerum fistularum, uniuscujusque toni, in quibus ipsæ fistulæ imponantur, ita ut firmiter stent, et ab inferioribus ventum suscipiant. In caudis autem linguarum scribantur litteræ secundum ascensum et descensum, cantus quibus possit cognosci quis ille, vel ille tonus sit. In singulis autem linguis fiant foramina singula gracilia, longitudinè dimidii digiti minoris, in anteriore parte, juxta caudas in longitudine, in quibus ponantur singuli clavi cuprei capitati, qui pertranseant in medio fenestallas, quibus inducuntur ipsæ linguæ a superiori latere domus usque ad inferius, et appareant clavorum capita

the thicker wood a square hole must be made in the centre, four fingers in breadth, and about which, borders must be left of the same wood of one finger in breadth and height, in which the bellows can be placed. In the upper part of the side, however, small hollows are made, through which the wind can arrive at the pipes. But the other part of the wood, which should also be uppermost, is measured out inside equally, where seven or eight small openings are disposed, in which the stops are carefully joined, so that they may have an easy means of being drawn out or restored, so however, that no air can come out between the joins.

In the upper part, however, cut small openings opposite the lower ones, which may be rather wider, in which may be joined so many pieces of wood, so that between these and the larger, the openings of the wood may remain empty through which the wind can mount to the pipes; for in these same pieces of wood openings should be made in which the pipes are to be made fast. The openings in which the stops are fitted in the front part should increase, like slanting windows, through which these stops are introduced and removed.

In the hinder part, under the end of these stops, holes are made equally wide and long of the size of two fingers, through which the wind can ascend from the lower to the upper parts, so that when the stops are pressed upon them these holes may be stopped by them; when, however, they are withdrawn they may again lie open. In those pieces of wood which are joined upon the stops openings are made, carefully and in order, according to the number of the pipes of every tone, in which these pipes are placed, so that they may stand firmly and receive the wind from the lower parts. But in the handles of the stops letters are marked, according to the rise and fall of the sound, by which it can be known which tone it may be. In each one of the stops single slender holes are made, half of the little finger in length, in the front part, near the handles, lengthwise, in which single copper headed nails may be placed, which may pass through the small windows in the middle, by means of which these stops are drawn from the upper side of the construction down to the lower, and the

superius ita, ut cum linguæ cantantibus organis educuntur, non penitus extrahantur. His ita dispositis conglutinentur hæc duo ligna, quæ domum organorum conficiunt glutine casei; deinde partes illæ quæ super linguas sunt junctæ, in quibus foramina stant, sicque circumcidantur diligentèr et radantur.

CAPUT LXXXIII.

DE CONFLATORIO.

CONFLATORIUM facturus, conjunge tibi duo ligna de platano modo quo supra, longitudine pedis unius, quorum sit una palma spissum, alterum tribus digitis, sintque in una fronte rotunda in modum scuti, et ibi pede et dimidio lata; in altera fronte obtusa, latitudine unius palmi. Quæ cum diligenter conjuncta fuerint incide in spissiori ligno in rotunda fronte foramina quod volueris, secundum numerum follium, et in obtusa fronte unum, quod sit majus. Deinde incide ab unoquoque foramine fossam unam deductim usque ad majus, per quas viam possit habere ventus flantibus follibus. Sicque conglutinabis ipsa ligna glutine casei, et circumdabis panno lineo novo et forti, quem linies eodem glutine ut adhæreat, facies quoque ligaturas ferreas fortes, interius et exterius circumstagnatas, ne possint ex tignea [1] dissolvi, quas configes clavis longis capitatis atque stagnatis, ita ut inter duo foramina ligatura sit, quæ comprehendat utrumque lignum a superius latere usque ad inferius. Deinde acquire tibi lignum curvum de quercu, sanum et forte, quod habeat in una fronte, a curvatura longitudinem pedis unius, in altera duorum, quod perforabis in utraque fronte terebro magno, quo forantur medioli in rotis aratri. Sed quia foramina non possunt sibi obviare propter curvaturam, fac tibi ferrum quod habeat

[1] ex tignaria? *quasi opere.*

heads of the nails appear above, so that when the stops are withdrawn from the sounding instruments, they cannot be quite extracted. These things being thus arranged, these two pieces of wood, which perfect the organ house, are joined together with cheese-glue; then those parts which are joined over the stops, in which the holes exist, are also pared round carefully, and scraped.

CHAPTER LXXXIII.

OF THE BELLOWS.

In making the wind-chamber, join together two pieces of wood of the plane tree, in the above mode, of one foot in length, one of which may be a palm thick, the other three fingers, and let them be round at one end, like a shield, and there a foot and a half wide, at the other end blunt, a palm in breadth. When these have been carefully fitted together, cut, in the round front in the thicker wood, the openings which you wish, according to the number of the bellows, and in the blunt end one, which must be larger. Then cut, from each opening, a hollow leading to the larger opening, through which the wind may have way to the working bellows; and you will thus glue these woods together with the cheese-glue, and you will bind them round with a linen cloth, new and strong, which you anoint with the same casein glue that it may adhere: you also make strong iron bindings tinned over within and without, that they may not become disunited from the woodwork, these you will fix on with long nails, headed and tinned, so that between two openings a binding may exist, which may include each wood from the upper to the lower side. Then procure for yourself a curved piece of oak wood, sound and strong, which must have at one end, from the curve, the length of one foot, in the other of two, which you will pierce in each end with a large auger, with which the middle portions are pierced in the wheels of ploughs. But because the openings cannot meet together, on account of the curve, make

caput rotundum in modum ovi,' et caudam longam gracilem, quæ imponatur manubrio, sitque juxta caput modicè curvum, cum quo calefacto, combures foramina interius in curvatura, donec sibi æqualiter conveniant. Quo facto, incide ipsum lignum [1] quadrico statum, ita ut in unoquoque latere uno palmo latum sit, ad mensuram conflatorii in obtusa parte. Post hæc conjunge ipsum lignum in longiori parte, ad inferius foramen domus organariæ, ita ut eidem ligno cauda incidatur, unius pollicis longa, quæ ipsi foramini inponatur, vel inferatur, et junctura tam subtiles sit, ut nichil flatus inter eam exire quæat. Alteram vero frontem conjunges eodem modo ad conflatorium, et ipsum lignum glutine casei firmabis, atque circumvolves panno totum lignum cum junctura, cui etiam circumfiges cuprum latum quod utriusque ligni oram capiat. His ita completis, si volueris organa ultra maceriam muri stabilire, ita ut infra monasterium nichil appareat, nisi sola domus cum fistulis, et ex altera parte muri folles jaceant, ita oportebit te ipsam domum convertere ut linguæ versus folles extrahantur, et in ipso muro arcus fiat in quo cautor sedeat, cujus sedes ita aptetur, ut pedes supra conflatorium teneat. Est autem foramen quadrum in medio arcus trans maceriam, per quod domus cum fistulis exponitur; et super collum conflatorii, quod in muro infra foramen lapidibus obfirmatum est, in sua junctura sistitur, atque super duos clavos ferreos æqualiter in muro confixos nititur, cui foramini fenestra lignea appendet, quæ dum clausa, sera et clave munitur, nemo ignotus superveniens congnoscere valet quid in ea contineatur. Exterius quoque, super organa, pannus spissus lignis interius extensus, in modum domunculæ, a laqueari in funiculo ad arcendum pulverem' dependeat, qui funiculus super ipsum laquear circa rotulam arte compositus, dum cantandum est organis trahitur, et domunculam elevat, finitoque cantu, denuò

[1] quadratò?

for yourself an iron which may have a round head, like an egg, and a long thin stem, which is fitted with a handle, and let it be slightly curved, near the head, with which, made hot, you burn the holes curved inside, until they meet together in an even manner. Which being done, cut this wood in a square manner, set so that it be one palm wide in each side, to the size of the wind-chamber in the blunt part. After these things join this wood on the longer part, to the lower opening of the organ construction, so that a projection may be cut to the same wood a thumb in length, which can be placed, or forced into this opening, and that the join be so subtle that no wind can escape from it. You join on in the same manner the other end to the bellows, and will fasten this wood with cheese glue, and will wrap round the whole wood, with the join, with cloth, to which you also fix a wide piece of copper which may also compass the edge of each wood. These things being thus completed, should you wish to establish the organ beyond the masonry of the wall, so that nothing may appear beneath the cloister, unless the erection alone with the pipes, and that the bellows may extend from the other side, you must so turn the construction that the stops may be drawn out towards the bellows, and an arch may be made in the wall itself in which the chanter can sit, whose seat is so adapted that he can keep his feet above the bellows. There is also a square opening in the middle of the arch through the masonry, through which the construction with the pipes is laid out; and upon the neck of the bellows which is in the wall, beneath, the opening is made firm with stones, it is supported at its junction, and is rested upon two long iron nails evenly fixed in the wall; to this opening a wooden window hangs, which, when shut, is defended by a lock and key, that no stranger coming unawares be able to learn what may be contained in it. Outside also, above the organ, a thick drapery, extended inside with wood like a dome, for warding off the dust, can hang by a rope from the ceiling, which rope arranged with art around a wheel above the ceiling itself, is drawn whilst the organ is sounding, and thus raises the roof, and the chant being finished, it is lowered upon the organ.

super organa deponitur. Habet quoque ipsa domuncula pinnam ex eodem panno, lignis quatuor in speciem trianguli extensam, in cujus summo[1] sperula lignea stet, cui funiculus inhæret. Folles et instrumentum super quod jaceant, secundum situm loci ad libitos tuos dispone.

CAPUT LXXXIV.

DE DOMO CUPREA ET CONFLATORIO EJUS.

SECUNDUM abundantiam fistularum dispone longitudinem et latitudinem domus, et fac formam in argilla macerata, siccatamque diligenter incide quâcunque mensurâ volueris, et cooperi cera, diligenter inter duas æqualiter spissas hastulas cum rotundo ligno attenuatâ. Deinde incide foramina linguarum in ipsa cera, et foramen inferius, per quod ventus introeat; additis spiraculis, cum infusorio cooperi eâdem argillâ semel, et iterum ac tertio. Cunque siccata fuerit forma, eodem modo funde quo supra formam turibuli. Conflatorium quoque formabis in argilla procedentibus undique inferius venti aditibus, ad similitudinem radicis unius arboris, et in summo in unum foramen convenientibus. Quod cum mensurate dispositum cultello incideris, cooperi cerâ, et fac sicut supra. Cumque domus fuderis conjunges interius altitudine unius digiti a fundo, tabulam cupream ductilem sub foraminibus linguarum æqualiter, ut supra eam ipsæ linguæ jaceant, ita ut possint æqualiter produci et induci, illitisque ipsis linguis tenui argillâ, reliquum domus perfundes liquefacto plumbo, per omnia, super ipsas linguas usque ad summum. Quo facto, ejicies ipsum plumbum diligenter designabisque foramina fistularum in linguis; deinde in ipso plumbo et cum gracili ferro, vel terebro, perforabis diligentissimè. Deinde sub linguis ventorum aditibus[2] facies, induces ipsas linguas singulas in suis locis, atque repones plumbum et cum malleo

[1] spherula ? [2] "aditus" MS.

This dome also has a spire, made from the same cloth, extended by four pieces of wood in shape of a triangle, at the top of which a small wooden ball can stand, to which the rope cleaves. The bellows and the instrument upon which they may lie, arrange at your pleasure according to the situation of the spot.

CHAPTER LXXXIV.

OF THE COPPER CONSTRUCTION AND ITS BELLOWS.

Dispose the length and width of the case according to the number of the pipes, and make a mould in beaten clay, and being dry cut it to whatever size you may wish, and cover it with wax carefully thinned, between two rods equally thick, with the round wood. Then cut the openings of the stops in this wax, and the hole below through which the wind can enter; the air-holes with the funnel being added, cover altogether with the same clay, and again, and a third time. And when the mould has become dry, cast in the same manner as the form of the censer abovementioned. You will also fashion the bellows in clay, the wind-issues proceeding everywhere below in the similitude of the roots of a tree, and meeting at the top in one opening. Which, when disposed in rule you have cut with a knife, cover with wax and act as above. And when you have cast the case, you join, inside, at the height of one finger from the bottom, a beaten copper plate, in an even manner under the openings of the stops, that these stops may rest upon it, so that they can be smoothly drawn forth and returned; and lining these stops with thin clay, you pour over the rest of the case some melted lead everywhere, over these stops up to the top. This being done, you cast out this lead and will carefully mark the openings of the pipes in the stops; then you will most carefully perforate in this lead with a thin iron or with a bore. Then you make the issues for the wind under the stops; you introduce these stops singly in their places, and you replace the lead and you

in percutiendo conjunges domui, ut nichil spiraminis exeat, nisi per foramina quibus fistulæ inponendæ sunt. Cum vero conflatorium fuerit fusum et limatum, atque uniuscujusque follis fistula suo inductorio coaptata, conjungi et firmiter consolidari debet ad domum organariam inferius, ita ut ventus suos aditus liberè inveniat, et per alias juncturas nullatenus[1] exeat. Hoc quoque sollerterius[2] procurandum est, ut in capite uniuscujusque follis, ante foramen fistulæ suæ, cuprum tenue dependeat, quod spiraminis claudat aditum, ita ut cum follis flando deponitur illud cuprum se elevet, et ventus pleniter exeat; cumque follis elevatur ut per ventilabrum suum flatum resumat, illud cuprum os ejus penitus claudat, et ventum quem emisit redire non permittat.

CAPUT LXXXV.

DE CAMPANIS FUNDENDIS.

COMPOSITURUS campanam primum incides tibi lignum siccum de quercu, longum secundum quod vis habere campanam, ita ut ex utraque parte extra formam emineat longitudine unius palmi, et quadrum in una summitate grossius, in aliam gracilius et rotundum, ut possit in foramine circumvolvi. Sitque deductim[3] grossius et grossius, ut cum opus fuerit perfectum facilè possit educi. Quod lignum in grossiori parte una palma ante summitatem incidatur in circuitu, ut fiat fossa duobus digitis lata, sitque lignum ibi rotundum, juxta quam fossam summitas ipsius ligni fiat tenuis, ut in aliud lignum curvum jungi possit, per quod valeat in modum runcinæ circumverti. Fiunt etenim duo asseres longitudine et latitudine æquales qui altrinsècus conjungantur et confirmenter quatuor lignis, ita ut sint ampli[4] inter se secundum longitudinem prædicti ligni; ut in uno assere fiat foramen in quo

[1] "nulla teneus," *habet Codex.*

[2] "Sollertius," *imò.*

[3] "deductum?"

[4] "ampla," *in Codice inven.*

fit them to the construction by beating with the hammer, so that no wind can issue, unless through the openings in which the pipes are placed. When the wind-case has been cast and filed, and the pipe of each air-issue fitted to its conductor, it should be joined together and firmly soldered below to the organ construction, so that the wind may find its access freely, and can in nowise issue through the other joints. This also is to be carefully provided, that a thin piece of copper may hang down before the opening of its pipe, which can close the access of the air-hole, so that when by the breathing of the bellows this copper is displaced, it may rise, and the wind may freely issue; and when the bellows is raised, so that it may recover air through its own ventilator, this copper can quite close its mouth and not permit the wind which it emitted to return.

CHAPTER LXXXV.

OF FOUNDING BELLS.

In making a bell, first cut a dry piece of wood, as long as you wish to have the bell, so that on every side it may protrude beyond the shape to the length of one palm, and let it be square at one larger end, at the other more pointed and round, so that it can be revolved in a hole. And let it be drawn out larger and larger, so that, when the work has been finished, it can easily be taken out. This wood must be cut around in the thicker part, one palm before the end, that a hollow may be made two fingers wide, and let the wood be there round; near this furrow the extremity of the wood is made thin, that it may be joined in another curved wood, by which it is able to be revolved like a lathe. Two planks are also made, equal in length and width, which are joined together and made firm with four pieces of wood, so that they may be wide between each other according to the length of the aforesaid wood; a hole should be made in one plank in which the

convertatur rotunda summitas, et in altero e contra æqualiter fiat incisura duobus digitis profunda, in qua volvatur rotunda incisura. Quo facto, sume ipsum lignum et circumpone ei argillam fortiter maceratam, inprimis duobus digitis spissam, quâ diligenter siccatâ, suppone ei alteram, sicque facies donec forma compleatur quantam eam habere volueris, et cave ne unquam superponas argillam alteri nisi inferior omninò sicca fuerit. Deinde colloca ipsam formam inter asseres superscriptos, et sedente puero qui vertat, cum ferris, ad hoc opus aptis, tornabis eam sicut volueris et tenens pannum in aqua madefactum eam æquabis.

Post hæc tollens adipem concide subtiliter in vase atque manibus macera, confixisque duobus æqualibus lignis spissitudine qua volueris, super asserem æqualem in medio eorum positum adipem attenuabis, et æquabis cum rotundo ligno, sicut cera superius, suppositâ aquâ ne adhereat, statimque ita repentè levabis et colocabis super formam, atque calido ferro circumsolidabis. Rursum attenuans eodem modo unam partem adipis, juxta priorem collocabis, sicque facies donec formam cooperies. Oram vero campanæ ad libitum tuum spissam facies. Adipem autem omnino refrigeratum ferris acutis tornabis, et si quid rari operis volueris circa latera campanæ, florum, sive literarum, in adipe exarabis, quatuorque foramina triangula juxta collum ut melius tinniat formabis. Deinde argillam cribratam et diligenter mixtam superpones, qua siccata, alteram et superaddes. Eâ itidem omninò siccatâ convertes formam in latus, atque leniter percutiendo educes lignum, rursumque, elevatâ formâ, foramen superius implebis argillâ molli, et curvum ferrum, in quo batillus pendere debet, in meditullio imprimes, ita ut summitates ejus foris emineant. Cumque siccata fuerit argilla, fac ut æqualis sit reliquæ formæ, atque cooperi adipe, ita ut summitates ferri in ipso abundanter hæreant. Post hæc forma collum, atque aures, et spiraculum sive infusorium

rounded top can be turned, and in the other alike, opposite, an incision must be made two fingers deep, in which the round cutting can be revolved. Which being done take the block itself and apply strongly beaten clay round it, first of all two fingers thick, which being carefully dry, apply another upon it, and you do thus until the mould be supplied as you may wish to have it, and beware that you never at any time superpose clay upon other (clay), unless that below has become perfectly dry. Then set this mould between the before-mentioned planks, and, the boy who can revolve it being seated, you will turn it as you may wish, and holding a cloth moistened in water you will smooth it.

After this, taking tallow, cut it up very finely and macerate it with the hands, and two even pieces of wood being fixed together of the thickness you may wish, you will thin out the tallow placed between them upon an even board, with the wooden roller, as the wax above, water being placed under that it may not adhere, and so you will immediately lift it suddenly, and will lay it upon the mould and will fasten it round with a hot iron. Again, thinning a piece of grease, in the same manner, you will fasten it next to the first, and do thus until you cover the mould. You make the rim of the bell of the thickness you please. You will turn the grease, when quite cold, with sharp instruments, and should you wish any ornament about the sides of the bell, of flowers, or letters, you will hollow them out in the tallow, and will fashion four openings near the neck, that it may sound better. You then superpose clay, sifted and carefully mixed, which being dry you add other above it. That again being quite dry, you turn the mould upon its side and remove the wood by striking gently, and the mould being again raised you will fill the opening above with soft clay, and you impress the curved iron, in which the clapper should hang in the middle, so that its extremities may project outside. And when the clay has become dry, make it even with the rest of mould and cover it with tallow, so that the ends of the iron may adhere well in it. After these things form the neck, and the handles, and the air-hole, or funnel,

desuper, et cooperi argillâ. Dumque tertio argilla per omnia fuerit siccata, circumpone ferreos circulos tam densè, ut non plus inter duos circulos quam latitudo manus, quibus circulis duas argillas superpone. Quibus siccatis converte ipsam formam in latus, et in interiori argilla, incide fossam magnam in circuitu et in profundo, ut non remaneat spissior uno pede, quia si integra esset forma interius, præ nimio pondere non possit levari, ne præ spissitudine transcoqui.

Deinde fac foveam in loco ubi volueris ipsam formam subintrare ad recoquendum, profundam secundum altitudinem ejus in latitudine, et cum lapidibus atque argillâ fac in similitudinem fundamenti, pedem fortem, supra quem forma stabit altitudine unius pedis, ita ut in medio ultra indirectum remaneat, spatium quasi via, pede et dimidio lata, in qua ardeat ignis sub forma. Quo facto configе quatuor ligna sursum procedentia usque ad æqualitatem terræ, juxta ipsum pedem, et statim reple foveam terra. Statimque deduces ipsam formam et statues eam in medio lignorum illorum æqualiter et ex una parte, sub ipsa forma, incipe terram ejicere. Cumque se inclinaverit, fode in parte altera, donec se rursum illic inclinet, sicque facies ex utraque parte quousque forma super pedem lapideum æqualiter sedeat. Mox ejectis lignis, quæ ad hoc solum confixa fuerint, ut formam rectè deducerent, assumptisque lapidibus qui flammam possint sustinere atque argillâ fac oram ex utraque parte ante illud spatium viæ, quam in medio pedis reliquisti, atque in circuitu operare fornacem, spatio dimidii pedis a forma. Cumque operando perveneris ad medium formæ, purga oram fornacis, et in ora ipsius formæ ex utraque parte fac unum foramen, per quod adeps possit effluere, suppositisque vasis, ignem et sicca ligna adhibe. Et cum calefactâ formâ cœperit adeps exire, perfice pede tepentem fornacem usque ad summum formæ, et super os pones operculum ex argilla sive ex ferro. Educto

above them, and cover with clay. And when the clay has a third time become dry, place iron hoops around so closely that there may not be more than the breadth of a hand between two hoops, upon which hoops place two layers of clay. These being dry, turn the mould upon its side and cut a large hollow in the inside, in the circumference and in depth, that it may not remain thicker than one foot, because, were the mould whole within, it could not be raised, on account of the exceeding weight, nor be cooked through, for the thickness.

Then make a cave in the place where you wish this mould to enter for cooking, deep, according to the height of the breadth, and make a strong base, as a foundation, with stones and clay upon which the mould will stand at the height of one foot, so that in the middle a rough space as a path, a foot and a half wide, may remain on either side, in which the fire can burn under the mould. Which being done, fix four posts, projecting upwards to the level of the ground, about this foundation, and immediately fill up the cave with earth. You directly lower the mould and establish it evenly in the midst of these posts, and begin to cast out the earth on one side, from under the mould. And when it shall have inclined, dig on the other side, until it again incline itself there, and do thus on every side until the mould lie in an even manner upon the stone base. Directly withdrawing the posts, which were fixed for this purpose alone, that they might guide the mould down straightly, and stones which can sustain the fire, being taken, and clay, make the mouth of the furnace on each side, before that space of the path which you had left in the midst of the base, and build the furnace around at the distance of half a foot from the mould. And when, in working, you have reached the middle of the mould, clear the mouth of the furnace, and make an opening in the rim of the mould itself, on each side, through which the grease may be able to flow out, and vessels being placed underneath, apply fire and dry wood. And when, the mould being heated, the grease has commenced to issue out, finish the warm furnace from the foot to the top of the mould, and lay a cover over the mouth with clay or iron. But the grease being

autem penitus adipe, obstrue foramina utraque argillâ maceratâ rectâ mensura, ita ut non violetur ora campanæ, et circa formam abundantius adhibe ligna, ut per totam diem sequentemque noctem ignis non deficiat. Interim tolle cacabum ferreum in fundo rotundum, huic solummodò operi aptum, qui ex utraque parte aures ferreas duas habeat, aut si maxima campana erit, duos vel tres, et illinies eos interius et exterius argillâ fortiter maceratâ, semel et iterum ac tertio, donec duobus digitis spissa sit, et sistes eos altrinsècus contra se, ita ut inter eos iri possit, et sub eis pones terram simplicem atque circumfiges paxillos ligneos in duobus verò locis, vel si opus fuerit tribus, ubi folles apponi debent, figes duos paxillos fortitèr æqualiter latos, et inter eos facies foramen contra oram cacabi, ita ut ventus inter eum veniat, et singulis foraminibus inpones singulos ferros tenues atque complicatos, ita ut in eis possint fistulæ follium firmiter jacere; sicque cum lapidibus et argilla facies super ipsum cacabum in circuitu fornacem, pede et dimidio altam, atque interius æqualiter linies cum eadem argilla, sicque carbones ignitos appones. Cumque singulis cacabis similiter feceris, folles, et cum instrumentis suis in quibus firmiter jaceant, appones, unicuique foramini duos, et unicuique folli deputabis fortes viros duos. Cum autem cacabi interius benè canduerint, incide unicuique duo ligna de quercu sicca et grossa, sic apta ut possint fundum interius implere, et inter ea foramen facies per quod possit eis influere, atque super hæc duo ligna, alia ejusdem mensuræ, et in circuitu ex eodem ligno pone quasi paxillos prominentes ab his lignis usque super oram fornacis.

Quo facto, ponderabis omne æramentum quod habes, aut quatuor partes sint cupri et quinta stagni, atque dispones unicuique cacabo, secundum suam capacitatem, suas partes. Deinde vadens ad fornacem formæ, eleva superius operculum et considera qualitèr se habeat. Si omninò canduerit interius recurra ad cacabos et primitùs immitte carbones grossos. Deinde im-

utterly withdrawn, close both openings with beaten clay, to the proper measure, so that the rim of the bell may not be injured, and supply wood more abundantly about the mould, that for the whole day and the following night the fire may not be wanting. In the mean time take an iron pot, round at the bottom, fit only for this work, which must have on each side two iron handles, or should the bell be large, two or three (pots) and you anoint them inside and out with clay beaten strongly, once and again and a third time, until it be two fingers thick, and stand them on either side opposite each other, so that there may be way between them, and place simple earth under them, and fix them round with wooden stakes, in two, or if necessary, three places; where the bellows should be applied you fix, strongly, two stakes equally wide, and between them you make an opening against the mouth of the pot, so that the wind can come into it, and in separate holes you insert separate irons, thin and bent, so that the pipes of the bellows may be able to lie in them firmly; and thus you make over this pot, with stones and clay, a furnace around it, a foot and a half high, and you line it inside smoothly, with the same clay, and so apply ignited coals. And when you have done alike to the separate pots, set the bellows with their instruments in which they may lie firmly, two to each opening, and to each bellows you will depute two strong men. When, however, the inside of the pot has become quite glowing, cut, to each one, two blocks of oak, dry and thick, so fit that they may be able to fill the bottom of the pot inside, and make an opening in the middle of them through which one might pour in, and upon these place two other pieces of wood of the same size, and around place a kind of stakes, from the same wood, protruding from these blocks above the mouth of the furnace. This being done, you will weigh all the brass-work which you have, or four parts may be of copper and a fifth of tin, and you appoint to each pot its proportions, according to its capacity. Then going to the mould furnace, raise the covering above and see how it may act. If it should quite glow inside, run back to the pots, and, first of all, put in some large coals. Then lay

pone cuprum ordinatim absque stagno, atque intermisce carbones adjiciens abundanter superius, interjectisque ignitis carbonibus fac ut folles incipiant flare, primò mediocriter, deinde magis ac magis. Cumque videris flammam viridem ascendere, jam incipit cuprum liquescere, moxque super ponens carbones abundanter, recurre ad fornacem formæ, et a superiori incipe longis forcipibus lapides evellere et foràs projicere. Hoc opus in hoc loco non quærit pigros operarios, sed agiles atque studiosos, ne cujusquam incuria, vel forma frangatur, vel quis alium impediat aut lædat, sive ad iracundiam provocet, quod omninò cavendum est. Ejectis vero omninò lapidibus et igne denuò certatim reponatur terra, ut fossa omnis circa formam diligenter repleatur, et sint qui semper circumeant cum lignis obtusis, mediocriter impingendo et pedibus fortiter calcando, ut terra quæ inponitur formam premat, ne cum pondus æris infunditur ullomodo frangi possit.

Repleta igitur hoc modo fossa usque ad summum, recurre ad cacabos, et ligno longo et torrido commove cuprum, et si senseris omninò liquefactum inpone stagnum, rursumque commove diligenter ut bene commisceatur, fractâque fornace in circuitu induce duo ligna fortia et longa in aures cacabi, adhibitisque viris strenuis et in hac arte peritis, fac eum levari cum omni diligentia et ad formam deferri, ejectisque carbonibus et favillis atque imposito collatorio panno fac morosè infundi. Interim cuba juxta os formæ auditu diligenter considerans qualiter eò intro procedat; et si senseris quasi leve murmur tonitru, dic ut modicè teneant, rursumque infundant; sicque interdum tenendo et iterum infundendo fiat ut æs æqualiter resideat, donec evacuetur cacabus ille. Quo amoto, mox alter delatus in eodem loco statuatur, fiat de eo sicut ex priori, et pari modo de tertio donec æs in infusorio videatur. Nec statim cacabus

in the copper, in order without the tin, and intermingle coals, casting them abundantly above it, and ignited coals being cast in, cause the bellows to commence blowing, at first moderately, then more and more. And when you see a green flame ascend, now the copper begins to melt, and immediately superposing coals plentifully, run back to the mould furnace, and with the long tongs begin to pluck out the stones, and to throw them away. This work does not demand in this place slothful, but agile and diligent workmen, lest through neglect of any kind either the mould be broken, or one may hinder or hurt the other, or provoke him to anger, which is above all to be guarded against. The stones and fire being ejected, the earth must be again hastily replaced, that the hollow about the mould may be again carefully filled up; and there may be those who are always passing round with blunted pieces of wood, beating moderately and trampling firmly with the feet, that the earth which is placed in may press upon the mould, lest when the weight of the brass is poured in, it in any way be broken. The hollow being then in this manner filled up to the top, return quickly to the pots, and with a long and charred piece of wood stir the copper, and if you should feel that it be quite melted, put in the tin, and again stir it carefully that it may be well mixed, and, the furnace being broken around, introduce two strong and long poles into the handles of the pot, and active men being called, skilful in this art, cause it to be raised with every care and carried to the mould, and the coals and ashes being thrown out and the strainer cloth put on, cause it to be poured in hardily. In the mean time lie down, near the mouth of the mould, carefully remarking, by listening, how far within it may proceed; and should you perceive as if a slight murmur of thunder, desire that they hold a little, and then again that they pour in; and so that sometimes by holding and again by pouring, the brass be made to subside evenly, until that pot be empty. Which being removed, another brought into the same place must be set up directly, the same is done with this as with the former, and in like manner with a third until the brass is seen in the funnel. Nor may the pot be imme-

amoveatur, sed aliquanto spatio teneatur, ut si æs descenderit denuò superfundatur. Quod si tu ab hoc labore portantium et diversè fundentium retrahere volueris, acquire tibi maximum cacabum qui sit in fundo æqualis, et fac ei foramen unum in latere ejusdem fundi, atque cooperi eum argillâ intus et extra, sicut superius. Quo facto sistes eum juxta formam non longius quàm quinque pedum spatio, et circumfige ei paxillos atque ignem cum carbonibus inpone. Cumque canduerit obstrue foramen cum argillâ, quod versum erit ad formam, et compone ei ligna quatuor, et paxillos interius fornacemque facito in circuitu, sicut superius. Deinde inposito cupro cum carbonibus et igne, adpositisque tribus ordinibus follium, fac flari viriliter. Interim habeas lignum siccum tantæ longitudinis ut possit procedere a foramine cacabi usqúe ad os formæ, cujus curvatura sit ampla. Quod cum ex omni parte cooperiveris argillâ et maximè superius, infodies ita ut æquale sit terræ sed juxta cacabum modice altius, atque superfunde ei ignitos carbones. Mox inposito stagno atque commoto cupro, sicut superius cum curvo ferro quod sit ligno fortiter affixum, aperi foramen, et astantibus, qui teneant duos colatorios pannos, sine eis fluere; interdum tamen tenendo sicut superius. Cumque forma plena fuerit, si quid æris in cacabo remansit, in summitate ligni grossi pone massam argillæ et ante foramen fortiter impinge ut eum obstruas. Hoc utroque modo fundendi possint etiam minores campanæ fundi ut secundum quantitatem earum fiant cacabi.

Cum vero æs in infusorio duraverit, fac ut certatim terra ejiciatur a fossa et exterius aliquantum refrigeretur terra. Ejecta vero terra, ipsa forma inclinetur in uno latere et terra supponatur, sicque fiat donec, eodem modo quo inposita, est a fossa ejiciatur. Quo facto, super unum latus omninò deponatur, et cum securibus aliisque ferris acutis qui sint infixi longis lignis, interior argilla certatim ejiciatur, quia si permittatur in ea

diately removed, but kept for a space, that, should the brass sink, it may again be poured over. But should you wish to withdraw from this fatigue of carrying and founding in parts, procure for yourself a very large pot, which must be flat at the bottom, and make an opening in it on the side at the bottom, and cover it with clay inside and without, as above. This being done, station it near the mould, not farther than a distance of five feet, and fasten it round with stakes, and lay in fire with coals. And when it has become glowing close the opening, which will be towards the mould, with clay, and arrange upon it four pieces of wood, and make the small stakes inside the furnace, as above. Then, the copper being placed in with coals and fire, and three ranges of bellows being applied, cause them to be manfully blown. In the mean time you have a dry piece of wood of such length that it can reach from the opening in the pot to the mouth of the mould, the bend of this must be ample. When you shall have covered this everywhere with clay and especially above, inter it that it may be even with the ground, but rather higher near the pot, and heap ignited coals upon it. The tin being placed in and stirred with the copper, as above with the curved iron which is strongly fixed upon wood, open the hole, and with the assistants, who can hold two straining cloths, allow them to flow out; sometimes withholding, however, as above. And when the mould has become full should any brass remain in the pot, place a mass of clay upon the end of a stout stick and press strongly in front of the opening that you may close it. In both these manners also smaller bells can be founded, according to the quantity the pots can make. When the brass shall have become hard in the funnel, cause the earth to be hastily cast out of the hollow and the ground outside to become somewhat cold. The earth being thrown out, this mould must be inclined on one side and be laid upon the ground, and this is done until, in the same manner as it was placed in, it is taken out of the hollow. This being accomplished, it is laid down entirely upon one side, and with hatchets and other sharp instruments which are fixed upon long pieces of wood, the inside clay is hastily cast out, be-

refrigerari, ab humore terræ inflaretur et campana absque, dubio finderetur. Qua ejecta, ipsa forma iterum erigatur super terram, sicque stet, donec exterius omnino refrigeretur; sicque frangatur argilla et circuli ejiciantur, et quicquid inæquale exterius fuerit, malleis acutis incidatur. Deinde in medio campanæ ponatur lignum, huic simile in quo primùm forma tornata est, et quatuor aliis lignis in modum crucis obfirmetur ora ejus, ita ut infusorium jaceat super unum asserem, et illud lignum super alterum, ut inposito curvo ligno, possit campana tornari, atque cum sabuleo lapide per omnia æquari. Post hæc, infusorium ex utraque parte limatum, diligenter frangatur, et circa collum duo ligna conjungantur, inferius per medium minus, et superius in circuitu majus; quæ ligna duobus circulis fortiter constringantur, atque ferreis vinculis ex omni parte circa aures colligantur. Illud vero majus lignum sit modicè longius quam campana sit lata, sit que in summitatibus aliquantum gracilius quam in medio, et in ipsis summitatibus habeat duos ferros grossos et rotundos, quorum longitudo sit intra lignum spacii dimidii pedis et extra unius palmi. Cumque aptaveris duas trabes ad suscipiendam campanam, fac in eis duas mensuras duobus digitis profundas, in quibus clavi illi magni involvantur, sub quibus etiam pones duos ferros curvos, ad servandas trabes. Habeat etiam illud grossius lignum in quo pendet campana in utraque parte singula foramina, in quibus ponantur duo ligna sursum respicientia, quibus funes innectantur ad pulsandum. Corium etiam spissum, de collo cervi circumponatur ferro illi curvo, quod interius hæret in medio campanæ, in quo batillus pendeat; qui sit tantæ longitudinis ut promineat extra campanam spatio latitudinis manus, sitque grossior in fine longitudine unius palmæ, sursumque gracilior.

cause, should it be permitted to become cold in it, it would be swelled out from the damp of the earth, and, without doubt the bell would be cracked. This being taken out, the mould must again be raised upon the ground and may so remain, until the outside has become quite cold; and so the clay may be broken and the hoops taken away, and whatever inequality should be outside, may be cut off with sharp hammers. Then, in the middle of the bell a block is placed, similar to that in which the mould was first turned, and four other pieces of wood are fastened firmly to its edge, so that the funnel may lie upon one post and this wood upon another, that, a curved wood being placed on, the bell can be turned, and with a sandstone be made smooth everywhere. Afterwards, the funnel, filed on every side, is carefully broken, and about the neck two pieces of wood are joined together, the lower, smaller one, through the middle, and the upper, larger, around it; which pieces of wood must be bound fast by two hoops, strongly, and are tied by iron chains about the handles everywhere. This larger wood should be rather longer than the bell is wide, and be somewhat thinner at the ends than in the middle, and at these ends it must have two thick and round irons, the length of which, within the wood, may be a space of half a foot, and beyond it, of one palm. And when you have fitted two beams for sustaining the bell, make two measures in them two fingers deep, in which these large nails can be enclosed, under which you also place two curved irons for preserving the beams. That larger wood in which the bell hangs must also have, on each side, single holes, in which two woods projecting upwards are placed; to these the ropes are tied for tolling. A thick leather also, of the stag's neck may be placed round that curved iron, which rests inside in the middle of the bell, in which the tongue must hang, which must be of such length that it may protrude beyond the bell for a space of the width of the hand, and let it be thicker at the end for the length of a palm, and thinner upwards.

CAPUT LXXXVI.

DE MENSURA CYMBALORUM.

QUICUNQUE vult facere cymbala ad cantandum rectè sonantia, ad unumquodque debet ceram dividere cum pondere, et a superioribus incipiat ut descendendo possit pervenire ad graviora. Unumquodque autem notet cum propria littera ut illud in divisione cognoscat. Inprimis faciat duas partes ceræ æquales cum libra, unam ad *a* litteram, alteram ad G. Ceram *a* litteræ dividat in octo æquales partes, et tantum ad ceram G litteræ quantum est in octava parte ceræ *a*. Similiter dividat ceram G per octo et tantum det F litteræ quantum est in summa ejus, et insuper octavam ejus partem, et habebit duos tonos continuos. In illo loco semitonium[1] debet esse, et hoc ita inveniat. Summam ceræ *a* litteræ dividat in tres partes, ipsamque summam det E litteræ, et insuper ejus terciam partem. Deinde det tantum ceræ D litteræ, quantum est in summa *a* et octavam ejus partem. Item tantum ceræ det litteræ C quantum habet G, et mediam ejus partem, itaque haberet duos tonos post semitonium. Deinde tantum ceræ tribuat B litteræ quantum est in tota summa F litteræ, et insuper terciam ejus partem, et habebit iterum semitonium; atque septem symphonias ab *a* littera usque ad B inveniat. Dyapason vero necdum haberet sine octavo cymbalo. Duplicet igitur totam ceram *a* litteræ et sic eam tribuat A litteræ, et nichil deerit. Dyatesseron, Dyapason, atque Dyapente Synemenon autem inveniat ita, tollat summam ceræ litteræ et tantum det F litteræ, et insuper medietatem ejus, ac constituat illam inter A et B. Omninò autem caveat qui cymbala formare aut fundere debet, ut de supradicta cera quæ tam cautè ponderata et divisa est, nichil mittat ad juga et spiramina, sed de altera cera faciat illa omnia.

[1] "semitonus," *imò*.

CHAPTER LXXXVI.

OF THE MEASURE OF CYMBALS.

Whoever wishes to make cymbals of proper sound for singing, should divide the wax for each one with a weight, and should begin from the highest, that by descending he may be able to arrive at the graver (cymbals). He can likewise note each one with its own letter, that he may know it in the partition. In the first place let him make two portions of wax equal with the balance, one for letter *a*, the other for G. Let him divide the wax of letter *a* into eight equal parts, and (give) so much to the wax of letter G as is in the eighth part of wax *a*: let him similarly divide wax G by eight, and give so much to letter F as is in its total, and an eighth of its part beyond, and he will have two consecutive notes. In that place the semitone should be, and let him thus find it. Let him divide the whole of the wax of letter *a* into three parts, and give this total to letter E and beyond, the third part of it. Then let him give so much wax to letter D as is in the total *a*, and the eighth part of it. Likewise let him give as much wax to letter C as G possesses and half a part of it, and he will thus have two notes after the semitone. Then let him afford to letter B so much wax as is in the whole amount of letter F and beyond, the third part of it, and he will have the semitone again; and let him find the seven concords from letter *a* to B. The octave he cannot yet have without the eighth cymbal. Let him therefore double all the wax of letter *a*, and so give it to letter A, and nothing will be wanting: the fourth, eighth and fifth chord let him find thus, let him take the amount of the wax of the letter and give so much to letter F and the half of it beyond, and let him establish it between A and B. He who should fashion or found the cymbals should above all take care, that he puts none of the above mentioned wax, which is so cautiously weighed and divided, to the necks and air-holes, but let him make all these from other wax. Let him have the great fore-

In magna providentia habeat ut, priusquam aliquid cymbalum fundatur, stagnum cum cupro misceatur, ut rectum sonum habeat. Quòd si alitèr fecerit non veniunt ad tonos. Quinta aut sexta pars debet esse stagnum, utrumque bene purificatum priusquam permisceatur ut clarè sonent. Si autem fusa cymbala minùs rectè sonuerint, hoc emendetur limâ vel lapide.

CAPUT LXXXVI.

DE CYMBALIS MUSICIS.

FACTURUS cymbala, primum aquire tibi lectionem et secundùm quod docuerit formam facito, atque ceram diligentèr pondera. Quas[1] cum fuderis, sicut supra dictum est, si quid per negligentiam vel incuriam de equitate tonorum defuerit, corriges. Si volueris cymbalum altiùs habere, in ora inferius limabis, si vero humiliùs, circa oram in circuitu.

CAPUT LXXXVII.

DE AMPULLIS STAGNEIS.

FAC tibi duos ferros longitudine manus et modicè graciliores minimo digito, qui sunt in una parte grossiores, in altera summitate deductim graciliores, ut possint ex forma deduci; habeantque in grossiori parte caudas tenues, ut singulis manubriis confingantur, quæ manubria sint rotunda; et habeant in altera summitate breves clavos rotundos, in quibus tornari possint. His ferris circumpone argillam, primò parum, deinde amplius secundum magnitudinem quam volueris. Quâ siccatâ fac tornatorium tuum eodem modo quo tornantur scu-

[1] qua ?

sight that before any cymbal be cast, the tin be mixed with the copper that it may have the right sound. Because should he have done otherwise, they are not brought to their tones. A fifth or sixth part should be tin, and be both well purified before they are mixed together, that they may sound clearly. Should, however, the cast cymbals sound imperfectly, this can be rectified with the file, or stone.

CHAPTER LXXXVI.

OF MUSICAL CYMBALS.

Being about to make cymbals first procure your directions, and according to what they may have taught, make the mould, and carefully weigh the wax. When you have founded these as mentioned above, should anything be wanting in justness of tone through negligence or carelessness, you correct it. Should you wish the cymbal to be higher, you will file about the mouth underneath (of the mould), but if flatter, round the rim in circumference.

CHAPTER LXXXVII.

OF TIN VIALS.

Make two irons for yourself the length of the hand and rather thinner than the little finger, which are thicker at one end, at the other extremity graduated more thinly, that they can be drawn out from the mould; and let them have at the thicker part thin projections that they may each be forged with handles, which handles must be round; and they must have, at the other end, short round nails by which they can be turned. Place clay round these irons, little at first, then more, according to the size you wish. This being dry, make your lathe in the same manner as trenchers and other wooden

tellæ et alia vasa lignea, ita ut una columpna firmitèr stet, et altera moveatur, quæ tamen cum apposita fuerit inferius clavo tenui firmabitur. Inter columpnas statue formam et utrosque clavos in suis foraminibus, corrigiaque circa lignum posita, atque sedente puero qui eam trahat, tornabis sicut placuerit ceramque superpones. Quâ similiter tornatâ, educ a manubrio formam cum ferro, appositisque spiraculis et argillâ superductâ atque siccatâ, ejice ceram et ad recoquendum in fornacem pone, modo quo superius. Cumque interius omninò canduerit ejice ab igne, et sic sine jacere donec refrigeretur, ita ut in manû aliquantum possit teneri. Statimque liquefacto stagno in patella ferrea, sive in testa, cum tempus fuerit infundendi adjiciatur ei modicum vivi argenti, ita ut, si est libra stagni quadrans sit vivi argenti, et sine mora formæ infundatur. Quæ cum fuerit omninò refrigerata, frangatur exterius argilla, et reposito manubrio, denuò in tornatorium reponatur, atque ex omni parte æqualiter tornetur, ad ultimum vero asperellâ poliatur. Post hæc modicum accipe de eisdem rasuris stagni et commisce parum vivi argenti, digitisque tuis fricabis donec omninò liquefiat; sicque cum panniculo circa ampullam tornando linies quoadusque sicca et clara remaneat; deducto autem ferro et interiori argilla, circa foramen inferius in quo erat ferrum, fodies in medio stagno fossulam, et in eo junges particulam ejusdem stagni, modicè spissiorem quam sit ampulla, atque interius pone lignum rotundum, cui innitatur ut non complicetur, et cum mediocri malleo exterius percute, donec fossuris illis inducatur et firmitèr stet. Aliter etiam ipsum foramen obstruere potes. Inpone ampullæ lignum ut supra, quod in summitate panniculo involves, plumbumque simplex, in foramine, rasa et cera illicò, liquefactum infundes, et ita festinantèr cum malleolo æquabis.

vessels are turned, so that one column may stand firmly, and the other can be moved, which, however, when it has been adapted, shall be fastened below with a thin nail. Adjust the mould between the columns and both the nails in their openings, and the strap being placed round the wood, and the boy who draws it being seated, you will turn it as you please, and overlay the wax. This being similarly turned, withdraw the mould from the handle with the iron, and the air-holes being placed on, and clay overlaid and dry, cast out the wax and place it in the furnace to recook, in the above mentioned manner. And when it has quite glowed inside, take it out of the fire, and so allow it to remain until it has become cold, so that it can be held in the hand awhile. And tin being instantly melted in an iron basin, or pot, a little quicksilver is added to it when it has become time for founding, so that, if there is a pound of tin, a fourth part must be (added) of quicksilver; and it must be poured into the mould without delay. When this has become quite cold the clay may be broken outside, and the handle being replaced, it must be again placed in the lathe and be turned smoothly everywhere, but at last it is polished with the rough grass. After this, take a little of the same scrapings of tin and mix with it a little quicksilver, and you will rub it with your fingers until it becomes quite liquid; and thus with a small cloth you anoint it, about the jar, by turning, until it remains dry and fair; the iron being taken out and the inner clay, also, you dig a small hollow in the middle of the tin, about the opening below, in which the iron was, and you join in it a small piece of the same tin, a little thicker than is the vial, and inside, you place a round piece of wood, upon which it may lean so that it may not be bent, and strike it outside with a moderate sized hammer until it is brought into these hollows and can stand firmly. You can also otherwise close this opening. Place the wood into the vial as above, the end of this you wrap in a small cloth; you pour pure melted lead into the opening, wax being also scraped on the same place, and you will thus quickly smooth it with the small hammer.

CAPUT LXXXVIII.

QUALITER STAGNUM SOLIDETUR.

PERCUTE in stagno quasi duos cyphos æquales, et conjunge illos in medio, ita ut ora unius in altera procedat, inpositoque illo qui continet cineribus calidis, partem ejusdem stagni, plumbi tercia parte admixta, percute tenuissimè, et intercidens particulatim circumpone; adhibitisque modicis carbonibus ignitis, mox ut incaluerit circumunge resinam abietis, et mox ipsas particulas liquescere ac circumfluere videbis. Mox carbonibus amotis, refrigeratum firmum erit. Hoc modo solidari potest quicquid in puro stagno est opus, videlicet, effusoria in ampullis et auriculæ, atque ligaturæ in quibus opercula pendent, et si aliquid foramen in fusili ampulla per negligentiam contigerit.

CAPUT LXXXIX.

DE FUNDENDO EFFUSORIO.

POTEST etiam effusorium facile ita formari, ut incidatur fissile lignum rotundum, et foretur terebro in longitudine, non usque ad finem, et findatur per medium, atque in integro illo formetur foramen, cui ferrum rotundum secundum interiorem amplitudinem infusorii, tenui argillâ illitum injungatur, et foris validè circumligetur, stagnumque, illi calefacto, infundatur. Quo refrigerato lignum solvatur, et ferrum ejiciatur, effusoriumque limatum et planatum, modo quo superius dictum est, vasi consolidetur.

CHAPTER LXXXVIII.

HOW TIN IS SOLDERED.

Beat, from tin two cups, alike, and join them together in the middle, so that the rim of one may pass into the other, and that which contains the other being placed upon hot ashes, beat very thinly a piece of the same tin mixed with a third part of lead, and cutting it up very small, lay it around (the join); and a few ignited coals being applied, as soon as it has glowed, anoint it round with resin of the fir-tree, and you will instantly see these particles melt and flow about. The coals being directly removed, when cold, it will be firm. In this manner, whatever work is in pure tin may be soldered, namely, the spouts and handles in vials, and the fastenings in which the covers hang, also should any hole have happened through negligence in the cast vial.

CHAPTER LXXXIX.

OF CASTING THE SPOUT.

The spout can also thus be easily formed; a piece of cleft wood is cut round, and is bored with the auger lengthwise, not quite to the end, and it is split through the middle; and in its whole part a hole is made to which a circular iron, according to the capacity of the interior of the spout, overlaid with thin clay, is inserted, and it is well bound round outside, and tin, it being made warm, is poured in. Which being cold, the wood is loosened, and the iron taken out, and the spout being filed and smoothed in the above mentioned manner, is fastened on to the vase.

CAPUT XC.

DE FERRO.

FERRUM nascitur in terra in modum lapidum, quod, effossum eodem modo quo cuprum superius frangitur et in massas confunditur, deinde in fornace ferrarii liquatur, et percutitur ut aptum fiat unicuique operi. Calibs dicitur a monte Calibe, in quo ejus usus plurimus invenitur; qui simili modo preparatur ut operi aptus fiat. Cum ergo ferrum præparaveris et inde calcaria, sive cætera equestria utensilia feceris, et ea auro vel argento decorare volueris, sume argentum purissimum, et percutiendo valdè attenua. Deinde habeas rotulam ligneam de quercu, longitudine pedis latam et tornatam, quæ sit in circuitu tenuis et in medio ex utraque parte spissam, ubi ei aliud lignum curvum transfigatur in quo possit volvi, cui etiam in una summitate aliud lignum curvum apponatur cum quo circumrotetur. Cumque ipsam rotam aptaveris inter duas columpnellas, fac circa oram ejus exterius incisuras in modum gradus, quæ retrò respiciunt, ut ipsæ columpnellæ in quibus rota vergitur, firmitèr sint fixæ super scamnum in latitudine, ita ut curvum lignum ad dexteram manus sit. Stet quoque adhuc una columpnella ad sinistram manum in anteriori parte juxta rotam, in qua sit fixum gracile lignum, ita ut super rotam jaceat et habeat in summitate sua particulam calibis, longitudine et latitudine majoris unguis, firmitèr per foramen infixam, et valdè acutam, ita ut cum rota volvitur illud lignum semper cadat ab uno gradu in alterum, ut sic vibratus calibs quicquid adponitur incidat. Cum verò limaveris calcar unum æqualiter, pone illud super carbones ardentes donec nigrescat, refrigeratumque tene manû sinistrâ et rotam volve dextrâ, appositumque calibi, incide subtiliter per omnia ex-

CHAPTER XC.

OF IRON.

Iron is formed in the earth, in form of stones, which (iron) is dug up in the same manner as the copper, above mentioned, and it is broken, and is mixed together in lumps, it is then melted in the iron worker's furnace, and it is hammered that it may become fit for any kind of work. It is called Calibs, from the mount Calybe, in which the most is known of its practice; wherefore it is prepared in the same manner that it may become fit for work. When, therefore, you shall have prepared the iron, and have made bits from it, or other equestrian utensils, and wish to decorate them with gold or silver, take the purest silver, and thin it much by hammering. Then you have a wooden wheel, of oak, a foot in diameter and turned, which must be narrow at the outer part, and everywhere thick in the middle, where another circular wood is fixed on to it, in which it can be revolved, to which also, at one end, another circular wood may be placed, with which it can be turned round. And when you have adapted this wheel between two small columns, make about its outer edge small cuttings like steps, which incline backwards; these columns, in which the wheel is displayed, must be firmly fixed upon a bench lengthwise, so that the round wood may be on the right hand. There may also stand yet another column at the left hand, in front, near the wheel, in which a thin wood must be fixed, so that it may lie upon the wheel and have at its extremity a small piece of steel, of the length and breadth of the smallest finger nail, firmly fixed through an opening, and extremely sharp, so that when the wheel is revolved, this wood may always fall from one step to another, that being so vibrated, the steel may cut into whatsoever is applied. When you have filed a spur smoothly, place it over the glowing coals until it has become black, and hold it, having become cold, in the left hand, and revolve the wheel with the right, and applying it to the steel, cut finely over the

terius in longitudine, et rursum dupliciter in latitudine. Quo facto, cum parvulo forcipe frica particulas argenti sicut volueris et superpone, atque cum eodem forcipe frica summitates argenti ut adhereant. Cumque totum operaveris, denuò pone super prunas ardentes donec rursum nigrum fiat, atque elevans forcipe, cum longo ferro ex calibe valdè æquali et manubrio infixo diligenter polies, suppositumque prunis, iterum calefaties rursumque cum eodem ferro fortiter polies. Quod si volueris illud per partes aut ex toto deaurare, in tua sit potestate. Hoc modo frœna et cetera instrumenta equestria vel quodcunque in ferro volueris incide modo quo superius, sed profundius, habeasque fila ex argento subtilissima atque ex auro, formaris tibi inde brevissimos flosculos et circulos, sive aliud quodcunque libuerit, et cum gracili forcipe super ferrum qualiter volueris pone, atque cum brevi malleo leniter percute ut adhæreat; sitque semper unus flosculus aureus alter argenteus. Impleto autem taliter spacio ferri totius, pone super prunas donec nigrescat, atque cum mediocri malleo percute diligenter, donec ubicunque ferrum apparet incisuræ illæ æquales fiant, et sic opus illud videatur quasi nigellum sit. Si vero in cultellis sive in aliis ferris litteras habere volueris, cum fossorio ferro fode eas inprimis, deinde facto filo argenteo grosso, forma cum gracili forcipe litteras, et inpone eas fossuris illis, percutiensque superius cum malleo imple eas. Hoc modo etiam flosculos et circulos facere potes in ferro, et cum filis ex cupro et auricalco imple. Si quid vero hujus operis vetustate seu negligentiâ fractum fuerit, si argentum quod est volueris acquirere, mitte illud in ignem donec candeat, tenensque sinistrâ manu cum forcipe, dexterâ longum plumbum frica super omnia loca ubi argentum apparet, et mox liquescente plumbo ipsum liquescit, et ei commiscetur; sicque plumbum comburitur et argentum acquiritur.

whole outside lengthwise, and again doubly in its breadth. This being done, with the small pincers rub and overlay small pieces of silver as you may desire, and with the same forceps rub the tops of the silver particles, that they may adhere. And when you have worked the whole, place it anew over the glowing coals until it is again made black, and raising it with the pincers, you carefully polish it with the long piece of steel, fixed in a handle and very smooth, and being placed over the coals, you again warm it and again polish it strongly with the same instrument. But should you wish to gild it in parts, or wholly, it is in your power. In this manner bits and other equestrian utensils, or whatsoever you will in iron, you cut in the above manner, but more deeply, you can also have very fine wires of silver and of gold, with them you can form for yourself very small flowers and circles, or any other thing which it may please you, and place it with the slender forceps upon the iron as you may wish, and with the short hammer strike gently, that it may adhere, and let there be always one small flower golden, the other silver. All the space, however, of the whole iron being filled up, lay it over the coals until it grow black, and beat it carefully with the middling sized hammer, until wherever the iron appear these incisions may become smooth, and thus the work may appear as if blackened. Should you wish to have letters upon blades or other instruments, sculp them first with the hollowing iron, then a thick silver wire being made, form the letters with the slender forceps and lay them in these hollows, and beating above them with the hammer fill them. You can also in this manner make flowers and circles upon the iron, and fill them with wires of copper and brass. Should, however, anything of this work become broken through age or carelessness, if you wish to acquire the silver in it, place it in the fire until it glows, and holding it in the left hand with the forceps, with the right rub a long piece of lead over all places where the silver appears, and immediately it liquefies with the melted lead and is mixed with it; and the lead is thus burned, and the silver procured.

CAPUT XCI.

DE SOLIDATURA FERRI.

FIUNT etiam ex ferro circuli tenues qui ponuntur in manubriis ferramentorum qui non possunt per se solidari, quibus in junctura circumvolvitur cuprum tenue, atque circumponitur modicum argillæ. Quâ siccatâ, cum ante fornacem sub carbonibus sufflat canduerit, mox liquefactum cuprum circumfluit et solidat. Hoc modo etiam claves stagnatæ, si franguntur, et alia quælibet in ferro solidari possunt. Quod si vis seras componere quibus manticæ serantur, percute ferrum tenue et circa aliud ferrum rotundum complica, atque conjunge ei fundum superius et inferius. Deinde circumpone ei corrigiolos ex eodem ferro et inter eos flosculos sive circulos qualiter volueris, sic tamen ut una particula semper inpingatur alteri ut adhæreat, ne cadere possit. Commisce quoque duos partes cupri et tertiam stagni, et comminue illud malleo in vasculo ferreo subtiliter, comburensque viniceum lapidem, adde ei modicum salis atque commisce aquâ, et liniens in circuitu circumsparge ipsum pulverem. Quo siccato, rursum superlinies confectionem illam spissius, inponensque prunis ac diligenter circumtegens, sicut argentum superius, eodem modo solidabis; refrigeratumque per se lavabis. Hoc modo quicquid volueris in ferro solidare potes, quod tamen nullo modo deauratur. Quicquid super stagnare volueris in ferro, primum lima et priusquam manu tangas, noviter limatum in patellam stagni liquefacti cum adipe projice, et cum forcipe commove, donec candidum fiat, eductumque fortiter excute, atque cum furfure et lineo panno purga. Seras ferreas atque ligaturas scriniorum et ostiorum cum feceris, ad ultimum calefacies et pice linies, clavi vero stagnati sint. Cum feceris calcaria, frenos et instrumenta sellæ humilium clericorum et monachorum, et ea æqualiter

CHAPTER XCI.

OF SOLDERING IRON.

Thin rings are also made from iron, which are placed upon the handles of iron instruments, which cannot be made firm by themselves, a thin piece of copper is folded round these at the join, and a little clay is placed around it. This being dry, when, being blown upon, it has become glowing under the coals before the furnace, the melted copper instantly flows around and solders it. In this manner also tinned keys, and any other things in iron can be soldered. But should you wish to make locks with which clothes chests are fastened, beat a thin piece of iron, and bend it round another round iron, and join a bottom to it above and below. Then place round it small hoops of the same iron, and between them small flowers or circles as you may wish, so, however, that one small piece may always impinge upon another that it may adhere and cannot fall off. Mix together also two parts of copper and a third of tin, and grind it with the pestle in an iron vase very finely, and burning the winestone, add to it a little salt and mix it with water, and anointing it around sprinkle this powder about it. Which being dry, you again overlay this mixture more thickly, and placing it upon the embers and carefully covering it about, as the silver above, you will solder it in the same manner; and, having cooled by itself, you will wash it. You can solder whatever you wish, in iron, in this manner, which can, however, in no way be gilt. Whatever you may wish to tin over, in iron, file it first, and before you may touch it with the hand, throw it newly filed into a pot of melted tin with grease, and stir it with the tongs until it becomes white, and being taken out, shake it strongly, and clean it with bran and a linen cloth. When you have made iron locks and bindings of caskets and doors, you warm them lastly and anoint them with pitch, but the nails are tinned. When you have made the stirrups, bits and saddle appendages of humble clerks and monks, and have filed them smoothly, warm them moderately and

limaveris, calefac mediocriter et frica super ea cornu bovis, sive pennas anseris, quæ cum a calore modicùm liquefacta ferro adhæserint, nigrum colorem et quod a modo ei convenientem præbebit.

CAPUT XCII.

DE SCULPTURA OSSIS.

SCULPTURUS os, primum forma tabulam cujus magnitudinis volueris, et superponens cretam, pertrahe cum plumbo imagines secundum libitum, atque cum gracili ferro designa tractus ut appareant; deinde cum diversis ferris fode campos quàm profundè volueris, et sic demùm ingenium et scientiam tuam sculpe imagines, vel aliud quod libuerit. Quod si volueris opus tuum auri petulâ ornare, gluten de vesica piscis qui dicitur huso subpone, et incisâ petulâ per particulas, sicut volueris suppone. Forma etiam manubria ex ebore rotunda sive costata, et fac foramen per medium in longitudine, deinde cum limis diversis ad hoc opus aptis amplifica foramen ut sit interius sicut exterius, et sit per rotum æqualiter et mediocriter tenue; atque pertrahe in circuitu subtiliter flosculos, sive bestias, aves, vel dracones collibus et caudis concatenatos, et cum subtilibus ferris campos transfora, deinde sculpe quàm gracilius et operosius possis. Quo facto, imple foramen interius ligno quercineo, quod cooperies cupro tenui deaurato, ita ut per omnes campos aurum videri possit; sicque ex eodem osse particuli duabus injunctis, obstrue foramen antè et retrò, quas obfirmabis osseis clavis, tam subtiliter, ut nullus considerare possit qualiter aurum impositum sit. Post hæc in anteriori particula fac foramen in quo cultellus inponatur, cujus cauda calefacta leviter potest inponi, quia lignum est interius et firmitèr stabit: fac etiam manu-

rub over them with the horn of an ox or the feather of a goose, when which, a little melted by the heat, have adhered to the iron, it will show a black colour which is in a manner suitable to him.

CHAPTER XCII.

OF SCULPTURING IVORY.

In sculpturing ivory, first form a tablet of the magnitude you may wish, and superposing chalk, portray with a lead the figures according to your pleasure, and with a pointed instrument mark the lines that they may appear; then carve the grounds as deeply as you wish with different instruments, and sculp the figures or other thing you please according to your invention and skill. But should you wish to ornament your work with a leaf of gold, lay on glue of the bladder of the fish which is called "huso," and the leaf being cut into small pieces, overlay it as you please. Fashion also round or ribbed handles from ivory, and make an opening through the middle lengthwise, then with various files proper for this work enlarge the opening that it may be inside as outside, and let it be smooth everywhere and moderately thin; and portray flowerets around it very finely, or animals, birds, or dragons twisted together by the necks and tails, and transpierce the grounds with very fine instruments, then sculp as gracefully and artistically as you may be able. Which being done, fill the opening inside with oak wood which you cover with thin gilt copper, so that through all the grounds the gold can be seen; and so two pieces being joined in from a particle of the same ivory, close the hole before and behind, you will fasten these on with ivory pegs, so cunningly, that no one may be able to see how the gold is laid in. After this make an opening in the small piece in front in which the blade is placed, the handle of which, being heated, can be easily inserted because the wood is within, and it will stand fast; make, also,

brium simplex qualiter volueris, et secundum quantitatem ejus fac foramen cui cultellus imponi debet, atque injunge ei lignum diligenter, et sicut lignum formatum est, ita fac formari caudam cultelli. Deinde tere thus lucidum in tenuissimum pulverem, et inde imple foramen manubrij, atque cum lineo panno humido involve cultellum juxta caudam tripliciter, ponensque ante fornacem, calefac ipsam caudam donec modicûm candescat, statimque infige manubrio diligenter ut bene conjungatur, et firmitèr stabit. Quod si aliquando vetustate, vel incuriâ, cultellus frangatur, ita ut particula ejus extra manubrium emineat, calefac forcipem ferrarij atque adprehende ipsam caudam et aliquantispèr tene, donec incalescat, et statim extrahe. Cum sulphure, quo trito, eodem modo firmari potest cultellus, non solum in osse sed in duro ligno.

CAPUT XCIII.

DE RUBRICANDO OSSE.

EST etiam herba rubrica dicta, cujus radix est longa, gracilis et rubicunda, quæ effossa sole siccatur, atque in mortario pilâ tunditur, et sic lexiva perfusa in olla radi[1] coquitur. Cui cum bene bulluerit, os elephantis seu piscis vel cervi impositum, rubrum fit. Possunt etiam ex his ossibus vel cornibus tornatili opere fieri noda[2] in baculis episcoporum, abbatium, atque minores noduli diversis utensilibus apti. Quos cum acutis ferris tornaveris cum asperella æquabis, et colligens rasuras in panno lineo desuper tornando fortiter fricabis, et omninò lucidi fient. Cineribus cribatis et laneo panno inditis poteris manubria cornea, et venatorum cornua, vel tabulas in lucernis polire; ad ultimum verò ne obliviscaris ea nucis oleo superlinire.

[1] rasâ ? [2] "nodi," imò.

a plain handle, and, according to its size, make the opening in which the blade should be placed, and join the wood carefully into it, and according as the wood is fashioned so cause the handle of the knife to be made. Then grind some clear Thus into the finest powder, and fill the opening of the handle with it, and envelop the blade near the handle with a wet cloth, in a threefold manner, and placing it before the furnace, warm this handle until it slightly glows, and immediately fix it carefully in the handle that it may be well joined in, and it will stand firmly. But should the knife be broken at any time, so that a small portion of it protrude beyond the handle, warm the iron-worker's pincers, and seize this handle and hold it for a short time until it grow warm, and immediately extract it. A knife can also be fastened in the same manner, with sulphur, ground, not only in ivory but in hard wood.

CHAPTER XCIII.

OF REDDENING IVORY.

There is likewise a herb called "rubrica," the root of which is long, slender, and of a red colour; this being dug up is dried in the sun and is pounded in a mortar with the pestle, and so being scraped into a pot and a lye poured over, it is cooked. In this, when it has well boiled, the bone of the elephant, or fish, or stag, being placed, is made red. The knobs in the staves of bishops and abbots, and the smaller nodules fit for different utensils can also be made in turned work from these bones or horns. When you have turned which, with sharp instruments, you will smooth them with shave grass, and collecting the scrapings in a linen cloth, you will rub them strongly, by turning upon them, and they are made quite bright. You will be able to polish horn handles, and the horns of huntsmen, or tablets in lanterns, with ashes, sifted, and set in a linen cloth; but at last you must not forget to anoint them over with walnut oil.

CAPUT XCIV.

DE POLIENDIS GEMMIS.

CRISTALLUM quod aqua durata in glaciem, et multorum annorum glacies duratur in lapidem, hoc modo limatur et politur. Tolle confectionem quæ dicitur tenax, de qua supradictum est, adhibitamque igni donec liquefiat, consolidabis christallum ad lignum longum quod ei simile sit in grossitudine. Quod cum refrigeratum fuerit utrisque manibus fricabis super lapidem sabuleum durum, additâ aquâ donec formam accipiat quam ei dare volueris, deinde super alteram lapidem ejusdem generis qui sit subtilior et æqualior donec omninò æquum fiat. Et accipiens tabulam plumbeam æqualem, pone super eam tegulam humidam quam cum saliva fricabis super cotem duram, atque desuper polies ipsum christallum, donec fulgorem accipiat. Ad ultimum verò super hyrcinum corium non denigratum neque unctum, sed in ligno tensum et clavis inferius affixum, fricaturam tegulæ pone salivâ humidam, et desuper diligenter frica, donec omninò lucidum fiat. Quod si christallum sculpere volueris, accepto hyrco duorum vel trium annorum, colligatisque pedibus ejus, incide foramen inter pectus ejus et ventrem, in loco cordis, et inpone christallum, ita ut in sanguine ejus jaceat, donec calefiat. Quod mox ejiciens incide in eo quod volueris, quamdiù calor ille durat, et cum ceperit refrigescere atque durescere, rursum repone in sanguine hyrci, calefactumque denuò ejice et incide, sicque facies donec sculpturam compleas; ad ultimum verò calefactum et ejectum cum panno laneo fricabis ut cum eodem sanguine ei fulgorem acquiras. Si autem nodos facere volueris ex christallo, qui baculis episcoporum vel caudæ labris possint inponi, hoc modo perforabis eos; fac tibi duos malleos mensura minoris digiti grossos, et penè palmi mensura longos, et in utraque summitate valdè graciles et bene calibatos. Cumque nodum formaveris incide in ligno

CHAPTER XCIV.

OF POLISHING GEMS.

Crystal, which is water hardened into ice, and the ice of great age is hardened into stone, is trimmed and polished in this manner. Take the composition which is called tenax, of which mention is made above, and applying it to the fire until it liquefy, you will fasten the crystal to a long wood, which must be similar to it in thickness. When this has become cold, you will rub it with both hands upon a hard sandstone, water being added, until it takes the form which you wish to give it, then upon another stone of the same kind, which must be finer and smoother, until it be made quite smooth. And taking a flat leaden tablet, place moistened tile upon it, which you will rub with saliva upon a hard hone, and you polish this crystal upon it until it takes a lustre. But at last, place the rubbing of tile, made moist with saliva, upon a goat's skin, neither blackened nor oiled, but stretched upon wood and fixed below with nails, and rub carefully upon it, until it becomes quite bright. But should you wish to sculp crystal, taking a goat of the age of two or three years and binding his feet, cut an opening between his breast and stomach, in the position of the heart, and lay in the crystal, so that it may lie in its blood until it grow warm. Taking it out directly, cut what you please in it, as long as the heat lasts, and when it has begun to grow cold and to harden, replace it again in the blood of the goat, and being made warm anew, take it out and cut it, and do thus until you complete the sculpture; at the last, being made warm and taken out, you will rub it with a linen cloth so that with the same blood you can procure a lustre for it. Should you, however, wish to make knobs from crystal, which can be placed upon the staves of bishops, or the tips of the stem, you will perforate them in this manner; make two hammers for yourself, of the thickness of the little finger, and almost a palm in length, and at each end very pointed and well steeled. And when you have formed the knob, cut a hole in a wood, so that it

foramen, ita ut dimidius in eo jacere possit, et cum cera confirmabis eum in eodem ligno ut adhæreat; tollensque unum malleolum percute leniter in medio nodi in uno loco, donec foramen parvum facias, sicque in medio percutiendo et in circuitu diligenter frangendo, cavaturam augebis. Cumque, sic persistendo, ad meditullium nodi perveneris, converte illum et in alteram partem fac similiter. Quem cum transforaveris, percute cuprum longitudine pedis unius et rotundum, ita ut foramen transire possit, accipiensque sabulum acutum aquà mixtum, mitte in foramen et cum cupro lima. Cum vero foramen aliquantum dilataveris, percute aliud cuprum grossius, cum quo similiter limabis; et si opus fuerit addes cuprum tertium grossius. Cumque ut volueris foramen ampliaveris, frange sabuleum lapidem subtiliter, et hoc imposito cum cupro novo limabis donec æquale fiat. Deinde tolle plumbum pari modo rotundum, additâque fricaturâ tegulæ, cum saliva, polies foramen interius, ipsumque nodum sicut supra exterius. Purissimum christallum rotundissimum formatum et politum, aquâque vel salivâ madefactum et claro soli adhibitum, isca quam tenturam vocant supposita ita, ut splendor in eam vibret, ignem velocissimùm trahit. Quod si christallum secare volueris, infige quatuor clavos ligneos super scamnum, inter quos christallum firmitèr jaceat, qui clavi sic stabunt, ut duo superius et duo inferius sic strictìm conjungantur, ut serra inter eos trahi vix possit, et in nullam partem flecti, imponensque serram ferream atque superjaciens sabulum acutum aquâ commixtum, fac stare duos qui eam trahant, quique sabulum cum aqua sine intermissione desuper jaciant. Hoc tamdiù fiat, donec christallum in duabus partibus dividatur, quas superfricabis et polies ut supra. Eodem modo secantur, fricantur atque poliuntur onix et berillus, smaragdus, jaspis et calcedonius, ceterique lapides preciosi; fit etiam tenuissimus pulvis de fragmentis christalli qui, mixtus aquâ, ponitur super æqualem lignum de tilia, et desuper fricantur

may be able to lie half in it, and you will fasten it with wax in this same piece of wood that it may adhere; and taking a small hammer strike lightly in the middle of the knob in one place until you make a small hole, and so by striking in the centre and by carefully breaking around it you will increase the hollow. And when by thus persevering you have arrived at the very middle of the knob, turn it round and do similarly upon the other side. When you have transpierced this, beat a piece of copper the length of a foot, and round, so that it can pass through the opening, and taking sharp sand mixed with water, place it in the opening and file with the copper. When you have somewhat dilated the opening, beat another thicker copper, with which you will file in a similar manner, and should need be you add a third thicker copper. And when you have enlarged the opening as you may wish, break a sand-stone very finely, and this being placed in, you will file it with a new copper until it become even. Then take a piece of lead, rounded in the same manner, and the powder of tile, with saliva being added, you polish the opening inside, and the knob itself outside, as above. Purest crystal of a very round form, and polished and moistened with water or saliva, and exposed in the light of the sun, tinder which they call "tentura" being placed under it, so that the light may shine upon it, attracts fire with the greatest velocity. But should you wish to cut crystal, fix four wooden pegs upon a bench, between which the crystal can lie firmly, which pegs will so stand, that two must be joined together above and two below, so closely that the saw can scarcely be drawn between them, and that it can in no part be turned, and placing on the iron saw, and casting over it sharp sand mixed with water, make two (assistants) stand who can draw it, and who must cast the sand with water upon it without intermission. This must be done until the crystal be divided into two pieces, which you will rub and polish over as above. In the same manner the onyx and beryl, malachite, jasper and agate and other precious stones are cut, rubbed and polished; a very fine powder is also made of fragments of crystal which, mixed with water, is placed upon a flat piece of lime-wood, and these

iidem lapides atque poliuntur. Jacinctus, qui durior est, hoc modo politur. Est lapis qui dicitur ismaris qui comminutus donec sit sicut sabulum, poniturque super cupream tabulam æqualem aquâ mixtus, et desuper jacinctus fricando formatur. Lotura verò quæ inde fluit diligenter in pelvi munda suscipiatur, et cum steterit per noctem, sequenti die aqua penitùs ejiciatur, et pulvis siccetur, qui postea super tabulam æqualem de tilia saliva humidus ponatur, atque desuper jacinctus poliatur. Lapides quoque eodem modo vitrei quòd cristallum fricantur et poliuntur.

CAPUT XCV.

DE MARGARITIS.

MARGARITÆ inveniuntur in conchis marinis et aliorum fluminum; quæ perforantur subtili ferro calibato, quod infixum sit ligno habenti rotulam plumbi parvulam, et alterum lignum in quo volvatur, cui sit inposita corrigia per quam circumducatur. Quod si opus sit ut alicujus margaritæ foramen majus fiat, filum cum modico subtili sabulo foramini inponatur, cujus fili summitas una dentibus, altera sinistrâ manu teneatur, dexterâque sursum ac deorsum margarita ducatur, interimque sabulum ut foramen latius fiat apponatur. Secantur etiam chonchæ marinæ per partes et inde limantur [1]margaritæ, in auro satis utiles, poliunturque ut supra.

[1] quasi?

same stones are rubbed upon it and polished. The amethyst, which is harder, is polished in this manner. There is a stone called emery, which is broken until like sand, and is placed, mixed with water, upon a smooth copper tablet, and by rubbing upon it the amethyst is fashioned. The washing which flows from it is carefully received in a clean basin, and when it has stood for a night, on the day following the water is entirely withdrawn and the powder is dried, this is afterwards placed, moistened with saliva, upon a smooth lime-wood tablet, and the amethyst is polished upon it. Glass stones, also, are rubbed and polished in the same manner as crystal.

CHAPTER XCV.

OF PEARLS.

Pearls are found in sea-shells and (shells) of other waters; these are perforated with a fine steeled instrument which is fixed in wood, having a small wheel of lead, also another wood in which it may be turned, to which a strap must be placed by which it may be revolved. But should it be necessary that the aperture of any pearl be made larger, a wire may be placed in the opening with a little fine sand, one end of which may be held in the teeth, the other in the left hand, and by the right the pearl is conducted upwards and downwards, and in the mean time sand is applied, that the aperture may become wider. Sea shells are also cut into pieces and are filed as pearls, sufficiently useful upon gold, and they are polished as above.

CAPUT XCVI.[1]

DE AUREA SCRIPTURA.

SI quis scripturam quærit sibi scribere pulchram
Ex auro, legat hoc quod vili carmine dico.
Aurum cum puro mero molat usque solutum
Hoc nimium fuerit; moneo quod sæpe lavet illud,
Nam quia deposcit hoc candens pagina libri.
Exin thaurini faciat pinguedine fellis
Hoc liquidum, si vult seu cum pinguedine gummi.
Atque rogo pariter calamo cum ceperit aurum
Illum commoveat, pulchrè si scribere quærit.
Hinc siccata sed ut fuerit scriptura, nitentem
Hunc nimiùm faciat ursi cum dente ferocis.

CAPUT XCVII.[2]

DE FLORIBUS AD SCRIBENDUM.

FLORES in varios qui vult mutare colores
Causa scribendi quos libri pagina poscit,
Est opus ut segetes in summo mane pererret
Et tunc diversos flores ortuque recentes
Inveniat, properetque sibi decerpere eosdem.
Cumque domi fuerint caveat ne ponat in unum
Illos, sed faciat quod talis res sibi poscit vel quærit.
Dum super æqualem petram contriveris istos
Flores, incoctum pariter tum congere gypsum.
Sic tibi siccatos poteris servare colores.
Ex quibus in viridem si vis mutare colorem,
Calcem commisce cum floribus, inde videbis
Quod tibi mandavi, veluti ipse probavi.

[1] "Eraclii" *videtur esse.* [2] "Eraclii" *capitula est.*

CHAPTER XCVI.[1]

OF WRITING IN GOLD.

SHOULD any one wish to fashion beautiful writing in gold, let him read what I say in lowly verse. Let him grind gold with pure wine until it has become well dissolved; I advise that he should often wash it, for the white page of the book demands this. Let him afterwards make this liquid, with the gluten of bull's skin, or, if he wish, with the gluten of gum. And when he has taken the gold with a stick or pen, let him stir it, should he seek to write beautifully. But after this, when the writing has become dry, let him make it very shining with the tooth of a wild bear.

CHAPTER XCVII.[2]

OF FLOWERS USED FOR WRITING.

HE who wishes to change flowers into various colours which, in the business of writing, the page of the book demands, must wander over the cornfields in early morning, and at the rising of the sun he can then find various fresh flowers, and let him hasten to pluck these for himself. And when they are at home, let him take care that he does not lay them together, but let him do what this thing demands of him. When you have bruised these flowers upon a smooth stone, then pile up unburnt gypsum together with them. Thus dry, you can preserve the colours for yourself. If you wish to change the colours of these to green, mix lime with the flowers, you will then see that I have bid you the thing which I have proved.

[1] Theophilus here quotes Eraclius.

[2] From Eraclius.

CAPUT XCVIII.

DE EDERA AC LACCA.

ROGATO a te frater karissime ut dicam tibi de hedera, quam poetæ atque artifices nimiùm dilexerunt, quia occultas vires quas in se continet agnoverunt: poetarum enim carmina cum recitarentur in theatro ante conventum romanorum, coronabantur hederâ:—artifices vero antiqui ex hac multos colores invenerunt, ex quibus unum scripto tibi ostendam. Mense martio, cum herbæ arboresque succum de matre terra suscipiunt, et iterum vires crescendi recipiunt, subulam accipe et ramusculos hederæ perfora locatim, et egreditur gummi liquor ex eis, de quo sanguineus coquendo color efficitur, qui lacca nuncupatur. Decoque ergo gummi liquorem quem tibi supra dixi cum urina, et habebis sanguineum colorem qui est utilis scripturis atque picturis. Ex hoc ergo parcia[1] efficitur qui pelles arietum ac caprarum rosea colore decorat.

CAPUT XCIX.

DE VIRIDI COLORE.

VIRIDEM si quis quærit colorem ad scribendi usum facere, accipiat folia virida ex herba quæ vulgò morella nuncupatur, eamque cum creta candida super petram marmoream diligenter terat, donec sint valdè liquida, atque ad usum scribendi optima. Hoc autem facto, pennam facere temperatam, seu pincellum in hunc colorem inunge, atque illumina capitales litteras quas ex eodem colore vis illuminare. Sed cave frater, ne nimiùm ponas ex creta cum succo foliorum.

[1] "phœnicia." *Qu.?*

CHAPTER XCVIII.

OF THE IVY AND OF LAKE.

At your request, dearest brother, that I should discourse to you of the ivy, which the poets and artists much loved, on account of the secret powers which they recognised it contained within itself:—for the songs of poets, when they had been recited in the theatre before an assembly of the Romans, were accustomed to be crowned with ivy:—the ancient artists also invented many colours from this, one of which, in writing, I can show you. In the month of March, when plants and trees take up their sap from mother earth, take an auger and perforate the small boughs of the ivy in places, and a gummy liquid will flow out from them, from which a blood colour is made, by seething, which is called lake. Seeth therefore the gum liquor, which I have before mentioned to you, in urine, and you will have the blood colour, which is useful in writings and paintings. From this also the "parcia"[1] is made, which ornaments rams and goats' skins with a rose colour.

CHAPTER XCIX.

OF A GREEN COLOUR.

Should one wish to make a green colour fit for writing let him take the green leaves of the plant which is commonly called nightshade, and carefully grind it upon a marble stone with white chalk until they be quite liquid, and best suited for the purpose of writing. This being done, dip a pen, or anoint a pencil in this colour, and illuminate capital letters which you wish to ornament with the same colour. But beware, brother, that you do not put too much chalk with the juice of the leaves.

[1] "phœnicia." *Qu.?* *See note.* "*Edera ac Lacca.*"

CAPUT C.

ITERUM DE EODEM.

COLOREM viridem qui vult ad usum scribendi sibi facere, in vase ereo mel cum aceto valdè immixtum æquo pondere infundat, ac deinde in sterquilinio, ubi calet plus, illud abscondat.

CAPUT CI.

ITEM.

ACCIPE vas cupreum, et lava illud intus et foris et mitte ad solem ut siccetur. Postea accepto melle purissimo perunge intus et foris. Deinde contere sal super lapidem, et cum eo totum prædictum vas asperge, et tunc idem vas pone super scultellam plenam aceto, positam in medio stercoris equorum, ita tamen, ut de stercore neque vas cupreum, neque acetum, contaminetur; et sic dimitte stare per quinque aut sex dies. Postea tolle idem vas, remoto stercore, et mitte ad solem donec siccetur, et tunc cum cultello abrade totum colorem qui de eodem vase confectus est, et mitte eum in aliquid vas, et misce eum adhuc cum melle, et sic depinge.

CAPUT CII.[1]

DE SCULPTURA VITRI.

O VOS artifices qui sculpere vultis honestè
Vitrum, nunc vobis pandam, velut ipse probavi.
Vermes quæsivi pingues quos vertit aratrum

[1] "Eraclii" *capitula est.*

CHAPTER C.

OF THE SAME AGAIN.

He who wishes to make for himself a green colour for service in writing, let him pour honey, well mixed with vinegar, into a brass vessel, and then let him bury it in stable litter, where it heats the most.

CHAPTER CI.

THE SAME.

Take a copper vessel and wash it within and without, and place it in the sun that it may become dry. Afterwards, taking the purest honey, anoint it over within and without. Then grind salt upon a stone, and sprinkle it over the whole aforesaid vessel, and then place the same vessel over a basin filled with vinegar placed in the midst of horse litter, so, however, that neither the copper vessel nor the vinegar be contaminated by the litter; and so leave it to stand for five or six days. Afterwards, the litter being removed, take the same vessel and place it in the sun until it becomes dry, and then scrape with a knife all the colour which is perfected upon the vase, and place it in any vessel and mix it with yet more honey, and so paint with it.

CHAPTER CII.[1]

OF SCULPTURING GLASS.

Artists! who wish to engrave glass in a beautiful manner, I now can teach you, as I have myself made trial. I have sought the gross worms which the plough turns up in the

[1] From Eraclius.

Per terram, atque simul jussit me quærere acetum.
Utilis ars istis rebus calidumque cruorem.
Ex hyrco ingenti, quem sollers tempore parvo
Herbâ ex hedera forti poni tecto religatum.
Sanguine cum calido post hæc vermes et acetum
Infudi, ac totam fialam clarè renitentem
Unxi; quo facto temptavi sculpere vitrum
Cum duro lapide piritis nomine dicto.

CAPUT CIII.[1]

DE PICTURA EX VITRO.

Ex vitro si quis depingere vascula quærit,
Eligat ipse duas de rufo marmore petras.
Inter quas vitrum romanum conterat, et cum
Ut pulvis terræ fuerit pariter resolutum.
Hoc faciat liquidum clara pinguedine gummi;
Septiès hoc scilicèt aqua nitidè ablue clara.
Post hæc depingat paginas quas finxit honestè
Figulus: hoc facto succense inponat easdem
Fornaci, caveatque, simul quo terra probata
Has teneat, quò sic valeant obstare calori:
Illasque faciat plena virtute nitentes.

CAPUT CIV.[2]

DE VIRIDI VITRO.

Qui vultis preciosum vitrum facere, auribus percipite hanc artem quam vobis de vitro scribere curavi. Pulverem arsi sulphuris cum viride vitro indagavi, pariterque pulverem arsi cupri michi quæsivi. Deinde vitrum valdè clarum supra

[1] "Eraclii" *capitula est.* [2] "Eraclii" *cap. est.*

ground, and the art necessary in these things also bid me to procure vinegar and the warm blood of a lusty goat, which I was careful to place under the roof for a short time, bound with a strong ivy plant. After this I infused the worms and vinegar with the warm blood, and I anointed the whole clearly shining vessel; which being done I essayed to sculp the glass with the hard stone called pyrites.

CHAPTER CIII. [1]

OF A PICTURE FROM GLASS.

SHOULD any one desire to paint small vases in glass, let him choose two stones of red marble, between these let him grind Roman glass, and when it has been reduced into powder like dust, let him make it liquid with clear gluten of gum; wash this, however, cleanly seven times in clear water. Let him after this paint the scrolls which the workman has handsomely fashioned: this done let him place these in the glowing furnace, and let him be careful that he keep these in the assayed earth, by which means they may be able to withstand the heat; and let him fashion them glowing with full perfection.

CHAPTER CIV. [2]

OF GREEN GLASS.

YOU who wish to make costly glass, learn, with your ears, this art of glass-making which I have taken pains to write for you. I sought out the powder of calcined sulphur with green glass, and likewise procured the powder of burnt copper.

[1] From Eraclius.
[2] This chapter is found in Eraclius, but written in verse.

petram marmoream redegi in pulverem, atque sulphuris ac cupri pulverem valdè tritum commiscui; factâ autem tali commixtione, illam puro gummi liquore temperavi, et super testam ex hac causa probandi pincello traxi, atque in fornacem eandem posui. Ast ubi rufa fuit, illam a fornace extraxi, et commixtio quam super testam pinxi in viride vitrum conversa est.

CAPUT CV.[1]

DE PICTURA CUM VITRO.

VITRUM quod nimium viret si quæris ad pingendi usum tibi facere, accipe cupri rubiginem, itemque pulverem arsi cupri, ac fac hoc quod utilis ars tibi quærit. Diligenter rubiginem et pulverem cupri cum vitro claro tere, et facta tali commixtione, causa probandi ex ea super testam pinge ac deinde in fornacem valdè incensam illam pone. Ast ubi pictura nimiò lucida est super eandem testam illam a fornace recipe: ut autem frigida erit, colorem preciosum in se recipiet. Hoc ideò frater tibi dico, quia quamdiù est vitrum calore perfusum non proprium sibi dedit colorem.

CAPUT CVI.[2]

DE ALBO VITRO.

ALBUM vitrum si quæris tibi facere ad pingendi usum, candidum sulphur cum vitro claro diligenter tere. Cum autem in pulverem redactum fuerit cum sulphure, illud super spissam testam pone, ac deinde in fornacem valdè incensam pone. Ut autem in calore ignis conglutinatum est

[1] "Eraclii" *videtur esse*. [2] idem.

Then I reduced very clear glass into powder upon a marble stone, and mixed the powder of sulphur and copper well ground; this mixture being made, I tempered it with pure gum water, and drew with the pencil upon a cup, for proof, and placed it in the furnace. But when it became red, I withdrew it from the furnace, and the mixture which I painted over the cup became converted into a green glass.

CHAPTER CV. [1]

OF A PICTURE WITH GLASS.

SHOULD you desire to make a very green glass, for painting, take the rust of copper, also the powder of burnt copper, and do as follows according to art. Grind carefully the rust and powder of copper with clear glass, and such mixture being made, for proof paint with it upon a cup and then place it in a very hot furnace. But when the picture is very glowing upon this same cup, take it from the furnace: when it is cold however it takes a costly colour. I tell you this therefore, brother, because so long as the glass is penetrated by heat it does not take its proper colour.

CHAPTER CVI. [2]

OF WHITE GLASS.

SHOULD you seek to make white glass for painting, grind carefully white sulphur with clear glass. When however it has been reduced to powder with the sulphur, lay it upon a thick cup and then place it in a very hot furnace. When it is agglutinated by the heat of the fire, withdraw it from

[1] From Eraclius. [2] From the same.

illud ab igne extrahe. Et si ex eodem scultellas arte figuli studiosè factas, vis depingere, illud ad usum contere picturæ, et te verte ad hanc artem quæ in primo libro scripta est. Hæc enim ita se habet. "Ex vitro si quis depingere vascula quærit."

CAPUT CVII.[1]

DE SCULPENDIS GEMMIS.

QUI cupit egregios lapides irrumpere ferro,
Quos dilexerunt reges nimiùm super aurum
Urbis Romanæ qui celsas jam tenuere
Artes, ingenium quod ego sub mente profunda
Inveni, accipiat, quem valdè est preciosum.
Urinam mihi quæsivi pariterque cruorem
Ex hyrco ingenti, modicò sub tempore pastum
Hederâ, quo facto, calefacto sanguine gemmas
Incidi, veluti monstravit Plinius auctor,
Artes qui scripsit, quas plebs Romana probavit,
Atque simul lapidum virtutes scripsit honestè;
Quorum qui noscit vires, plùs diligit illos;
Nam primi reges urbem qui jam tenuerunt,
Gemmis ornarunt vestes auro renitentes,
Ex quibus insignis primus fuit Aurelianus.
Qui proprias vestes gemmis contexit et auro.

CAPUT CVIII.[2]

DE PRECIOSIS GEMMIS.

PRECIOSAS gemmas si quæris lucidas facere accipe ea quæ sunt hic scripta. Petram marmoream valdè æqualem tibi aquire, facitoque hoc quod utilis ars tibi ostendit. Gemmam æqualem super hanc petram lævi extrica manu, sicque obscuritatem citò perdet, et recipiet preciosum nitorem.

[1] "Eraclii" cap. est.   [2] idem.

the fire. And if you wish to paint upon those plates, carefully made by the potter's art, grind it for the service of the picture, and turn towards that art which is described in the first book. This so contains it: "Ex vitro si quis depingere vascula quærit."—(C. 103.)

CHAPTER CVII. [1]

OF SCULPTURING GEMS.

Who should desire to cut with iron the rare stones which the rulers of Rome, who formerly sustained the noble arts, much delighted in upon gold, let him know the invention, which I with profound thought have discovered, which is very precious. I procured urine with the fresh blood of a lusty goat, fed for a short time upon ivy, which being done, I cut the gems in the warm blood, as the author Pliny has pointed out, who wrote upon the arts, which the Roman people put to proof, and who likewise well described the virtues of stones; he who knows the powers of which favours them the more. For the first kings, who long since held the city, ornamented, with gems, their garments resplendent with gold, of whom the most remarkable was Aurelian, who covered his robes all over with gems and gold.

CHAPTER CVIII. [2]

OF PRECIOUS GEMS.

Should you desire to make precious gems bright, know what is here written. Procure a marble slab, very smooth, and act as useful art points out to you. Rub with a light hand the smooth gem over this stone, and it thus soon

[1] From Eraclius. [2] idem.

Sed tibi frater sit notum si dura fuerit gemma atque æqualis magis lucida ac perspicua erit.

CAPUT CIX.[1]

DE SCULPENDIS GEMMIS.

SUNT nonnulli qui ferris ad incidendos lapides temperamentum quærunt idèoque scripsi hanc artem quam probavi ut et periti artifices sciant. Hyrcinum sævum tempore illo cum ureretur yrcus amore accepi, atque ferrum quod temperare volui in illius pinguedine extinxi, sicque in maximam versum est duritiam.

CAPUT CX.[2]

DE EBORE PETALA AURI DECORANDO.

OMNIS incisio quæ in ebore decoratur petulam auri sibi quærit. Quam si vis super ebur facere ponere, facito hoc quod tibi scripto ostendo. Quære tibi clarum ex valdè clarum gummi liquorem, qui ex vesica cethi fit. Hæc enim vulgaritèr huso nuncupatur. Si autem ex eadem habueris, partim hanc decoque cum aqua in vase, ille moxque in gummi liquorem convertitur. Ex eodem ergo incisionem eboris quam vis auro decorare, pincello unge, ac deinde petulam, remotus a vento, pone.

[1] "Eraclii" *cap. est.* [2] idem.

loses its dulness and receives a valuable lustre. But note, brother! should the gem be hard and smooth it will be the more bright and clear.

CHAPTER CIX. [1]

OF CUTTING GEMS.

There are some who seek a tempering for irons, for cutting stones, I have therefore written this art which I have tried, that skilful artificers may know it also. I took a wild goat when in heat, and quenched the iron which I wished to temper in his fat, and it was thus changed to the greatest hardness.

CHAPTER CX. [2]

OF ORNAMENTING IVORY WITH GOLD LEAF.

All sculpture which ornaments ivory demands leaf gold. Should you wish to cause this to be placed upon ivory, do what I point out to you in writing. Seek glaire and the very clear gummy liquid which is made from the bladder of a large fish. This is vulgarly called "huso." Should you possess this, cook a portion of it in a vessel with water, and it is immediately turned into a gum liquor. When you wish therefore to decorate the sculpture of ivory with gold, anoint it with this same (liquor), with a pencil, and then, removed from the wind, lay on the leaf.

[1] From Eraclius. [2] idem.

CAPUT CXI.[1]

DE CUPRO FELLIS PINGUEDINE DEAURANDO.

EX fellis pinguedine si cuprum quæris deaurare illud prius cultello rade, ac deinde cum ursino dente festina lucidum facere; et hoc facto, fellis pinguedinem super illud cum pincello facete trahe, cumque siccata fuerit iterum atque iterum trahe, super hanc eandem pinguedinem, et cave ne plus trahas pincellum in unum locum quam in alterum, sed sit æqualiter fellis liquore coopertum. Ne tibi videatur falsum quod dico, qui hanc artem veram esse probavi, atque auxiliante deo, qui fons est sapientiæ, excogitavi.

DE TEMPERAMENTO VESICÆ ESCINI.

VESICAM husonis mollifica in aqua donec eam inter manus pinsando, ex ea facias quasi cerotum, et tunc mitte eam in ollam in limpidissimam aquam, et pone ad focum ut non bulliat; sed tantum calorem habeat ut liquefactam, in aquam convertatur. Dein cola eam per mundum pannum in pelvim, et sine quod in frigido loco ad ventum accedat ut quasi coagulet. Cum digitum super ponens inpresseris, si viscus resistit et ab illa impressione non frangitur, liquefac ad ignem, et funde super aurum et operare in stupa nimìs calida. Si autem viscus nimìs crassescat admitte parum aquæ et operare. Si autem tam mollis sit quod non possit impressionem digiti sustentare, coque meliùs ad ignem facilè poteris et hunc viscum mollire firmum facere. Nunquam gummi addas auro vel aliis metallis: Nam citò cadet quidquid, id gravis, ex eo glutinatum erit, exceptis coloribus, qui etiam non perstabunt, nisi optimè conterantur et tenuissimè libris illiniantur.

[1] "Eraclii" *cap. est.*

CHAPTER CXI. [1]

OF GILDING COPPER WITH GALL.

Should you wish to gild copper with the unctuous substance of gall, first scrape it with a knife, and then with a bear's tooth quickly polish it; and this being done, paint the gall with a pencil over it, and when it has become dry, paint it again and again, and take care that you do not draw the pencil more in one place than another, but that it be equally covered with the liquor of gall. Let not what I tell you appear false, who have proved this art to be true, and have invented it, the God, whose fountain is of wisdom, assisting.

OF THE TEMPERING OF THE STURGEON'S BLADDER.

Soften the sturgeon's bladder in water until, by bruising it between the hands, you can make it like a cerate, and then place it in very clear water in a pot, and put it to the fire, so that it may not boil, but may receive such heat that, being liquefied, it may be converted into water. Then strain it into a basin through a clean cloth, and leave it in a cold place that it may have access to the air, that it may coagulate. When, laying on the finger, you have pressed it, should the gluten resist, and not be broken by that pressure, melt it at the fire and pour it upon the gold, and work it very hot, with tow. But should the gluten grow too thick, admit a little water and work. Should it, however, be too soft, so that it cannot retain the impression of the finger, cook it better at the fire, and you can easily soften this gluten at the fire and make it firm. You never add gum to gold or other metals: for whatever, it being hard, shall be gummed with it, quickly falls off, colours being excepted, which also will not stand well, unless they are very well ground together and are very thinly painted on the books.

[1] From Eraclius.

DE SIGNIS INVESTIGANDÆ AQUÆ.

SIGNA investigandæ aquæ hujusmodi inveniuntur. Tenuis juncus, Salix erraticus[1], Vitex, Alnus, Harundo, Hedera, aliæ quoque quæ sine humore nasci non possunt. Quandò autem in lacunis similia nascuntur facile his credendum est. Itaque sic inventiones aquæ probabis; fodiatur ergò ubi hæc signa fuerint inventa ne minus in latitudinem pedes tres, in altitudinem quinque, et circa solis occasum, vas plumbum, autem æneum, mundum, intrinsecùs punctum, oleo in unam fossuram inversum collocetur, supraque fossuram frondibus vel harundinibus missis terra inducatur. Item aliâ die aperiatur, si sudores aut fistulæ inveniantur, is locus sine dubitatione aquam habebit. Item si vas, ex creta, siccum non coctum, eadem ratione positum et opertum fuerit, si is locus aquam habebit, alia die vas humore solutum invenietur. Vellus lanæ similiter in eo loco positum si tantum humoris collegerit ut aliâ die exprimi possit, magnam copiam aquæ locum habere significat. Lucerna plena oleo, incensa si in eodem loco similiter adoperta, aliâ die lucens fuerit inventa, indicabit eum locum habere aquam, propterea quod omnis calor ad se trahit humorem. Item si in eodem loco (ignem[2]) feceris et vaporata terra humidum nebulosumque fumum resuscitaverit, et ostendit locum habere aquam. Cum hæc fuerint ità reperta certis signis, in altitudinem putei defodiendi erunt, quousque caput aquæ inveniatur, aut si plura fuerint in unum colligantur. Maximè tamen sub radicibus montium in regione septentrionali, signa aquæ sunt quærenda. In his enim locis suaves et salubres et habundantes inveniuntur; quandò naturæ beneficio a solis cursu separantur, et arborum aut montium umbris velatæ, frigidâ gratiâ æstate, hyberno tepidâ suavitate, profluent.

[1] "erratica"!

[2] In Codice, lacuna est, in hoc loco, quam implevimus.

EXPLICIT THEOPHILUS.

OF THE SIGNS IN SEEKING WATER.

The signs in tracing water are found to be of this kind. The slender rush, the creeping willow, the hemp tree, the alder, reed, ivy, and other (plants) which cannot be produced without moisture. Forasmuch as similar things are produced in marshes, it is easy to have confidence in these. You will likewise try these devices for water; the place, therefore, where these signs are found, must be dug, not less in width than three feet, in depth five; and about sunset, a clean leaden or brazen vessel punctured inside is properly placed, with oil in a hole, and green leaves, or reeds, being placed over the hollow, the earth is brought over it. On another day it is opened; should moisture, or rills, be found, this place will, without doubt, have water. If likewise a dry vase of chalk, not burnt, should be placed and enclosed in the same fashion, if this place will have water, the vase will be found dissolved by humidity. Should fleece of wool, placed likewise in this spot, collect so much moisture that upon another day it can be expressed, it shews that the place will have a great plenty of water. If a lantern full of oil burnt in the same place, similarly covered, should be found shining upon another day, it will indicate that this place possesses water, because all heat attracts moisture to itself. Likewise, should you make a (fire[1]) in the same place, and should the heated earth raise up a moist and nebulous smoke, it also shews that the place possesses water. When these things have thus been found by certain signs, the wells will be dug out in depth, until a source of water be found, or, should there be many, they may be collected in one. The signs of water are mostly to be found, however, under the feet of mountains on the northern situation. For in these places they are found sweet, salubrious and abundant; when, through the beneficence of nature, they are withdrawn from the course of the sun and veiled by the shadows of trees, or mountains, they flow forth with cool welcome in summer, with warm pleasantness in winter.

[1] There is here a void in the manuscript which we have filled up.

END OF THEOPHILUS.

ADDENDA.

DE TEMPERAMENTO MINII ET VERMICULI, ET LAZURII.

IN vermiculo quarta pars minii addenda est si habeatur quorum inde color ad illuminandum et clarior et ad regulandum facilior. Quod utiquè diligenter tritum et in tenuissimum pulverem redactum, addatur parum aquæ et cum ipsa aliquantulum molatur, et in cornu recolligatur, post laventur lapides aquâ quæ in cornu similiter recipiatur; hoc autem caveatur ne nimis aquæ infundatur, quando trititur, quòd non possit cum multa benè aqua moli, aut colligi. Collectum autem in cornu cum aqua cornu utiquè aquâ repleto, moveatur cum ligno et postea tamdiù sinatur requiescere, donec color separetur ab aqua jacens in fundo cornu, et tunc demùm aqua lenitèr ejiciatur. Quod cum tota ejecta fuerit, infunde cornu clarum ovi, et sic exinde poteris operari.

Similiter faciendum est de lazuro, excepto quod, in distemperando, tertia pars vini cum claro adhibebis, quod exindè color pulcrior et clarior erit. Lazur lavandum est aquâ post decem dies, propter fœtorem suum, vermiculum autem post mensem duabus vicibus, vel tribus; hoc autem caveatur ne clarum in lazuro diutiùs moretur.

Eodem modo molendum est viride de Grecia. Nam viride terrestre molendum est aquâ, et postea in eo ponitur clarea, sed tantummodo cum vino. Quidam autem infundunt vinum in vase cupreo et miscent viride cum vino, deinde reponunt illud in loco aliquantulum humido, octo diebus, postea exponunt illud ad calorem solis usque ad decimam horam diei, et iterum mittunt in locum suum ad terram, et sic cottidie faciunt, donec ad spissitudinem perveniat ut inde scribere valeant,

ADDENDA.

OF TEMPERING MINIUM, VERMILION, AND AZURE.

If a fourth part of minium is added to vermilion, a colour is procured from it brighter for illuminating and easier to direct. Which also is carefully ground and reduced into the finest powder, a little water may be added and it is ground with it a short time and is collected into a shell, the stones are afterwards washed with water, which is similarly received into the shell; this must however be guarded against, that too much water be not poured in, because it cannot be well ground with much water, or be gathered together. But being collected in the shell with water, the shell is likewise filled with water, it must be stirred with a stick and be afterwards left to rest until the colour, lying in the bottom of the vessel be separated from the water, and then, at length, the water may be lightly drawn off. But when it shall be all cast out, pour the white of egg into the horn, and so you can work with it.

Blue is to be similarly treated, excepting, that in tempering, you will admit one third part of wine with the glaire, which colour will also be fairer and brighter. Lazur is to be washed in water after seven days on account of its odour, but vermilion after a month, twice, or three times; this must be guarded against, that the glaire does not remain too long with the azure.

Greek green is to be ground in the same manner. For green earth is to be ground in water, and the glaire is afterwards put into it, but with wine only. But some pour wine into a copper vessel and mix the green with wine, they then leave it in a somewhat damp spot for eight days, they afterwards expose it to the heat of the sun until the tenth hour of the day, and they again lay it upon the ground, in its place, and thus they act daily until it has arrived at a solidity proper for writing; they then replace it gently in a copper or

et tunc recipiunt illud leniter in vase cupreo vel vitreo, et iterum infundunt vinum super feces, et reponunt in supradicto loco, et sic faciunt per totum annum, addentes aliquantulum de viridi. Qui autem citiùs volunt habere, viride molunt illud cum vino ut supra dictum est, et tunc enim inde scribitur quasi vermiculum vel azorium, molendum est cum vino; tunc accipies vinum optimum et pone in aliquo vase eneo vel cupreo et bullies illud. Quo cocto et mundato de spuma, custodi illud, et inde distempera viridem colorem, et pone ad tepidum solem, vel lentum (ignem[1]), donec spissus sit mensuratè, et posito in eo de croco et de pulvere ossis combusti, alteram contrahet virorem et meliorem; vel si miscueris novum cum veteri, alteram viriditatem habebit; vel si totum siccatum fuerit vel nimis crassum pone parum de aqua. Pone prætereà viride in vino ac frica satis digito: quo sedato, accipe quod liquidum est et pone ad lentem solem vel in loco ubi spissari possit. Quandò aptum fuerit ad scribendum pone in vase cupreo vel de enea et diù poteris conservare bonum. Si nigrior fuerit pone aliquantulum saffrani vel de pulvere ossis combusti. Si citiùs vis illuminare, accipe de vitello ovi crudi, et misce cum eo viride mellum[2] vel vinum, et cum hoc liquore mole supra petram viride, et inde distempera, et sic bonum erit.

DE LIGNO BRISILLO.

LIGNUM brisilli cultello raditur in vase et superfunditur ei clarea ovi. Quo peracto, et postquam cœperit maturescere ponitur in eo alumen circa mensuram congruam, hoc brisillum postquam maturatum fuerit, emitendum est liquor et in conca alia reservandus. Quo facto, iterum ponenda est clarea in eodem brisillo, et postquam maturata fuerit extrahenda est. Quod tamdiù fiat quamdiù brisillum claram illam incoloraverit: hoc autem cave, ne bris. sine alumine distemperes alioquin a pergameno totum bris. paulatim de-

[1] "ignem," *supposita est.* [2] "mellinam" *qu.?*

glass vase, and again pour wine over the sediment, and place it again in the above mentioned place, and they do this the whole year, adding a portion of green. Those, however, who wish to procure it sooner, grind this green with wine as directed above, and then it is used for writing as vermilion, or azure, it is ground with wine; you then take the best wine and put it into any brass or copper vessel, and you boil it. This being cooked and cleansed from froth, keep it and temper the green colour with it and place it in the warmth of the sun, or a slow fire, until it has become moderately thick, and putting yellow and the powder of calcined bones into it, it contracts yet more, and better, green; or if you mix new with the old, it will possess another green colour; should it have become quite or nearly dry, add a little water. Moreover, place the green in wine and rub it well with the finger: this having settled, take the liquid portion and put it in the mild sunshine, or in a place where it can become inspissated. When it has become fit for painting, place it in a copper or brass vessel, and you can keep it good for a long time. Should it become darker, put to it a little saffron or powder of calcined bones. Should you wish to illuminate more speedily, take the yolk of a fresh egg and mix mead or wine with the green, and with this liquor grind the green upon a stone, and temper with it, and it will thus be good.

OF BRISIL WOOD.

Brisil wood is scraped with a knife into a vase, and white of egg is poured over it. This being done, and after it has commenced to mature, alum is put into it, about the proper measure; after this brisil has become matured the liquor is withdrawn and kept in another vessel. This done, glaire is again to be placed upon the same brisil, and it is to be withdrawn after it has become matured. This is done as long as the brisil shall colour the glaire: beware of this, however, that you do not temper brisil without alum, otherwise all the brisil fades from the parchment, and the glaire alone will re-

cidet et sola clara remanebit. Igitur quotiens bris. tuum volueris facere rubeum, quod solet facile discolorari et spissescere, impone alumen et sic meliorabitur, et renovabitur sæpe clarea cum spissum fuerit. In bris. si misceas album, fiet roseus color. Si misceas azurum, fiet purpureus.

DE SINOPLO.

SINOPLUM eodem modo moles quo vermiculum. In eo miscere poteris parum albi et erit roseus color. Item si misceas cum albo parum sinopli erit carmineus color: aut iterum si misceas cum sinoplo auripigmentum, vincente auripigmento, erit rufus color.

DE BRISILLO.

FRAGMENTUM brisilli pones in vasculo ferreo vel eneo, et etiam cortice ovi, cum aqua, et fac bullire lentè donec aliquantulum sit decorata; et refrigerata modicum, deinde pone alumen bonum, temperate quia benè salsasum velles illud, postea calefac modicum movendo omnia. Refrigerato, eo pone clarum ovi et dimitte donec maturum sit post duæ vel tres dies. Quod si nimis clarum est pone ubi possit spissari, non tamen ad solem, et sic meliorabitur. Pone et fragmentum brisilli benè minutum in clarea forti, et post duæ vel tres donec sit maturatum. Pastellum quoque poteris distemperare secunda vel tertia vice, sed cave ne totum siccatum sit. Azur terrestre mole super petram cum aqua, movendo digito et apponendo aqua, ut possit per pannum transire postea cola per pannum delicatum ut mundior sit. Quo purificato et exsiccato, pone claream fortem; postea accipe de vitello ovi crudi et misce cum aqua et vino æqualiter, et valdè pone parum in colore, et faciat melius de

main. Therefore, as often as you wish to make your red brisil, which is accustomed to become discoloured and to thicken, put in some alum, and so it will be improved and, when become thick with the glaire, will often be renewed. If you mix white with brisil it will make a rose colour. If you mix blue, it will make purple.

OF SINOPER.

You grind sinoper in the same manner as vermilion. You can mix a little white with that, and it will be a rosy colour. Also if you mix a little sinoper with white it will be a carmine colour: or, again, if you mix orpiment with sinoper, the orpiment being overcome, it will be a red colour.

OF BRISIL.

You place the shred of brisil in a small iron or brass vessel with, also, the shell of an egg, and cause it to boil gently, until it has become somewhat stained with colour; and being a little cooled, put some good alum into it, temper it as you wish it well seasoned, afterwards warm it a little, stirring all the things. Being cold, put glaire of egg in it and leave it until, after two or three days, it has become matured. But should it be too clear, place it where it can become thick, not in the sun, however, and so it will be improved. Also put the shred of brisil, very fine, into strong glaire, and after two or three (days) it will become matured. You can likewise temper woad a second or third time, but beware that it do not become quite dry. Grind blue earth upon a stone with water, stirring it with the finger and applying water, that it may pass through a cloth, afterwards strain it through a delicate cloth, that it may be cleaner. This being purified and dried, put to it some strong glaire; afterwards take yolk of fresh egg and mix it with water and wine in equal parts, and put very little into the colour, and it will make it flow better from the pen. This is likewise serviceable for all

penna exire. Quod utiquè ad omnes colores valet, et si nigrior fuerit, bis vel ter lavabis aquâ, vel et ampliùs, et sic meliorabitur per duæ vel tres dies, potes in eo dimittere claream, sed quam sæpius mutabis tanto melior erit. Potes quoque distemperare azur albugine, fricando digito in vasculo, donec satis sit, et postea lavabis cum aqua, et eo siccato pone claream puram, et post duæ vel tres dies iterum lavabis pro ovo inveterato et nigro facto, et dimitte donec siccatum sit propter humorem aquæ.

DE TEMPERAMENTO COLORUM [1].

AZURIUM Saracenorum bonum est. Item aliud azurium Romanum, et aliud dicitur indium: viride Græcum, viride terrestre, vermiculum, minium, album de Apulia, album de ossibus, et album de plumbo, brisillum, auripigmentum, ocrum, safranum, sinoplum, gorma, distemperatio bruni, gipsum, foliolum.

In azur. Romano potest misceri album de Apulia. Itèm potest misceri auripigmenti et est viride croceum. Item si ponas brisil erit purpura. Item si ponas vermiculum erit brunum. Viride de græcia potest misceri cum albo de Apulia utroque cum vino temperato, autem utro illorum cum ovo, et sic fiet album viride. Item si ponas in viridi safranum, erit viride croceum, ita tamen si cum vino safranum fuerit distemperatum adde et si vis album. Eodem modo de viridi terrestri excepto quod molitur cum aqua, et postea ponitur in ea clarea. In vermiculo si misceas album fiet carminum. Si misceas azur romanum erit brunum. Album de Apulia potest misceri cum azuro solo, et iterum cum azuro et brisillo, et iterum cum azuro romano, necnon et potest misceri cum viridi terrestri. Album de ossibus cum auripigmento potest misceri, quæ mixtura de alio fieri non potest, quod utiquè album tantum pictoribus est necessarium. Auripigmentum cum

[1] "ab Eraclio excerpto."

colours, and should it become darker, you will wash it twice or thrice with water, or even more, and so it will be improved in two or three days, you can allow the glaire to remain; but the more often you shall change it the better it will be. You can likewise temper azure with white of egg, by rubbing with the finger in a small vessel until sufficient, and you will afterwards wash it with water, and being dry you put pure glaire to it, and you will again wash it after two or three days, on account of the stale egg turning it black, and spread it until it has become dry, because of the moisture from the water.

OF THE TEMPERING OF COLOURS.

THE "blue of the Saracens" is good. Also another "Roman blue," and another called "indigo." Greek green, green earth, vermilion, minium, white of Apulia, bone white, and white lead, brisil, orpiment, ochre, saffron, sinoper, the preparation of brunus, gypsum, folium.

Roman azure can be mixed with white of Apulia: it can likewise be put to orpiment, and it forms a yellow green. Likewise, if you put brisil to it, it will be purple: also, if you put vermilion it will be "brunus." Greek green can be mixed with white of Apulia, both tempered with wine, and both of them with egg, and thus a whitish green will be made: also, if you put saffron into green it will be a greenish yellow, however, if the saffron be tempered with wine, add white if you wish it. Green earth, after the same manner, excepting that it is ground with water, and glaire is afterwards placed in it.

In vermilion, should you mix white, it will make carmine; if you mix Roman blue it will be brunus: white of Apulia can be mixed with blue alone, and again with blue and brisil, and again with Roman azure; it can also be mixed with green earth. Bone white can be mixed with orpiment, which mixture cannot otherwise be made, this white is therefore necessary to painters.

magno labore trititur, et idcircò, more piperis, terendum est in mortario, vel, si illud non habes, involuntum in corio, deinde in marmore cum aqua sicut cæteri colores. In cujus temperamento accipe duæ partes ipsius, et tertiam de vitello ovi crudi, et pulveris ossis combusti plus, insimul commixti, et simul misce; omnes enim colores moluntur cum aqua, qua exhausta et diligenter ejecta, ponitur in eis clarea, præter in viridi de Græcia. Ocrum moliter cum aqua, sed non est necesse nisi pictoribus murorum, et in opere litterarum aurearum. Safranum potest distemperari cum clarea ovi, vel cum vino, et fit rufus color, sic ut brisillo misceri possit. Colores in pergameno clari et spissi hi sunt, Vermiculum. Auripigmentum, Viride græcum, Sanguis Draconis, Gravetum. Indicum, Carminum, Crocus, Folium, Brunum, Minium, Album, Nigrum, optimum ex carbonibus vitis cum ovo sicut alii colores.

DE MIXTURA COLORUM. [1]

AZURIUM incides de nigro, maptizabis auripigmento. Item misce cum albo plumbo, incides de azur, maptizabis de albo plumbo. Vermiculum incides de bruno, maptiza auripigmento. Item misce vermiculum cum albo plumbo, et fac colorem quod dicitur rosa, incides de vermiculo, maptiza de albo plumbo. Auripigmentum incides de vermiculo, et illi maptizabatura non est, quòd deturpat alios colores. Tamen si vis facere clarum videre, auripigmentum misce cum indico, incide de nigro, maptiza auripigmento. Sanguis draconis incides nigro, maptiza albo plumbo. Item misce sanguis draconis cum auripigmento, incides de nigro, maptiza de albo plumbo. Viride incides de nigro, maptiza de apulia. Item misce viride cum albo, incides de viridi maptiza albo plumbo. Item misce gravetum cum albo plumbo, incides de

[1] ab Eraclio excerpto.

Orpiment is ground with great labour, and is therefore to be ground in a mortar like pepper, or, should you not have this, rolled in a skin, then upon the marble with water, as the other colours. In the tempering of this, take two parts of it, and a third (part) of yolk of fresh egg, and more of the powder of calcined bones, mixed together; all colours are ground with water, which being withdrawn and carefully taken out, glaire is put into them, except in Greek green.

Ochre is ground with water, but it is not necessary unless to painters upon walls and in gold work of letters.

Saffron can be tempered with glaire of egg, or with wine, and a red colour is made, so that it can be mixed with brisil.

The bright and thick colours for parchment are these, Vermilion, Orpiment, Greek green, Dragon's blood, Gravetum, Indigo, Carmine, Saffron, Folium, Brunum, Minium, White, Black, the best from vine charcoal, (tempered) with egg, as the other colours.

OF THE MIXTURE OF COLOURS.

You break blue with black, you will design with orpiment. Also mix it with white lead, break it with blue, design with white lead. Break vermilion with brunum, design with orpiment: also mix vermilion with white lead and make the colour called rose, break it with vermilion, design with white lead. Break orpiment with vermilion, and there is no relief to it, because it would debase the other colours. However, should you wish to make it appear bright, mix the orpiment with indigo, break it with black, design with orpiment. Break dragon's blood with black, design with white lead: likewise mix dragon's blood with orpiment, break with black, design with white lead. Break green with black, design with Apulia: likewise mix green with white, break with green, design with white lead. Mix, also, "gravetus" with white lead, break with gravetus, design with white lead.

graveto maptiza albo plumbo. Indicum incides de azurio, maptiza de albo plumbo. Item misce indicum cum albo plumbo, incides de indico, maptiza de albo plumbo. Crocum incides de vermiculo, maptiza de albo plumbo. Item misce crocum cum albo plumbo, incides de croco, maptiza de albo plumbo. Folium incides de nigro, maptiza de albo plumbo. Item misce folium cum albo plumbo.

SI VIS FACERE LITERAS AUREAS VEL ARGENTEAS VEL CUPREAS VEL EREAS AUT FERREAS.

ACCIPE limam et metallum illud et limando fac pulverem. Postea accipe gummam prunariam et pones eam in aceto, dimitte per diem et noctem et postea extrahe foras et mitte eam in aquam claram aliquantulum tepidam et ibi dimitte per diem et noctem. Postea accipe gummam et limaturam et mole super petram fortiter, et distempera cum aqua, in qua distemperatus est pulvis ille, tantum ut bene possis scribere. Si non habes gummam accipe moniacam et distempera cum aqua calida, in qua moniacam dimittes per medium diem. Postea distempera ut dictum est utrinque, et fac literas quas volueris. Quas utiquè siccatas polies leviter cum dente lupi vel canis, et hujusmodi aut cum lapide polito, vel adamantino.

SI VIS FACERE VERMICULUM BONUM.

ACCIPE ampullam vitream et lini eam de foris de luto, vel argillosa terra et pone in eam dua pondera sulfuris albi, vel crocei coloris, et unum pondus argenti vivi et pone super duas petras et tunc appone ignum lentissimum. Tamen cooperias operculos ampullæ de parva tegula vel petra et quamdiù videris fumum rubeum quasi vermiculum, sic tolle ab igne, et habebis vermiculum bonum.

Break indigo with azure, design with white lead: also mix indigo with white lead, break with indigo, design with white lead. Break saffron with vermilion, design with white lead: also mix saffron with white lead, break with saffron, design with white lead. Break folium with black, design with white lead: also mix folium with white lead.

OF MAKING GOLD, SILVER, COPPER, BRASS, OR IRON LETTERS.

TAKE a file and that metal (you may choose) and make a powder by filing. Afterwards take the gum of the plum-tree and put it into acid, leave it for a day and night and afterwards take it out and put it into clear water, somewhat warm, and leave it there a day and night. Afterwards take the gum and filings and grind them strongly upon a stone, and temper with water, with which this powder is to be so tempered that you may be able to write. If you have no gum, take gum ammoniac and temper it with hot water, in which you leave this ammoniac half a day. Afterwards temper both as above and make the letters which you wish. These likewise dry, you polish them gently with a wolf's tooth, or that of a dog, and in this manner either with a polished stone, or adamant.

OF MAKING GOOD VERMILION.

TAKE a glass bottle and line it outside with lute or argillaceous earth and place in it two parts weight of white or yellow sulphur, and one part weight of quicksilver and place it over two stones and then apply a very gentle fire. And you cover the mouth of the bottle with small pieces of tile, or stones, and when you see a red smoke like vermilion so take it from the fire and you will have good vermilion.

SI VIS FACERE AZURIUM OPTIMUM.

ACCIPE ollam novam et mitte in ea laminas purissimi argenti quantas volueris, et pone illam ollam in vindemiam quæ est projecta de torculari sive de tina, et cooperi ollam cum laminis de ipsa vindemia et serva diligenter usque ad xv. dies, et sic aperies ollam illam, et siccata quod est in laminis rade in mundissimo vase. Quod si amplius volueris fac iterum similiter.

SI VIS ALIUM AZURIUM FACERE.

ACCIPE ampullam de purissimo cupro et imple fortissimo aceto, et cooperi diligenter os ejus, ne aliquid humoris vel vaporis possit exire, addens et si necesse est ad hoc tenacem terram vel pastam; et ipsam ampullam ita clausam pone in aliquo calido loco aut in terram, aut in fœnum projectum de stabulo, et sic dimitte per unum mensem, et tunc aperi illam ampullam, et quod inveneris in ea dimitte ad solem siccare.

FINIS.

OF MAKING THE BEST AZURE.

TAKE a new pot and place leaves of the purest silver in it, as many as you please, and place this pot in the grape pressings which are thrown from the press or vat, and cover the pot with layers of this grape refuse and keep it carefully until the fifteenth day, and so open the pot, and scrape whatever has dried upon the leaves into a very clean vessel. Should you wish for more, act again in a similar manner.

OF MAKING OTHER AZURE.

TAKE a small vase of the purest copper and fill it with the strongest vinegar, and cover its mouth carefully, lest any humidity or vapour may escape, adding to this, should it be necessary, a tenacious earth, or lute; and place this jar thus closed in some warm place, or in the ground, or in the litter thrown from the stable, and so leave it for one month, and then open this jar and expose what you may have found in it to dry, in the sun.

FINIS.

NOTES TO BOOK III.

CHAPTERS XVIII. AND XIX.

The reader will probably remark the expedient to furnish carbon during the process of tempering iron or steel, by the burnt bone of the ox, or the skin with animal fat. The knowledge of tempering iron or steel appears to be very ancient, as in Proverbs, xxvii. 17, "Iron sharpeneth iron," would indicate.

C. XXIII.

The expressions "very pure gold and silver," "purest gold," found in Scripture, warrant us in the belief that cupellation is a process of very ancient date. "Take away the dross from the silver, and there shall come forth a vessel for the finer."[1] "As the fining pot for silver and the furnace for gold: so is a man to his praise."[2]

The ancients knew that gold and silver were rarely found in a state of purity; the "χρυσὸς ἄπυρος" of the Greeks was the Arabian gold of the xlvii. chapter of Theophilus[3]; the gold which had been purified by cupellation was called "ὄβρυζον,"—"aurum obryzum," or "ad obrussam" of Pliny. The ancients were also in the practice of employing lead for purifying gold and silver. "They add a proportion of lead, according to the quantity of gold."[4]

It would perhaps be well, in this place, to inquire whether the ancients were ignorant of the action of the mineral acids, or the

[1] Proverbs, xxv. 4.
[2] Ib. xxvii. 21.
[3] Diodorus Siculus, II. 161. Vol. 1.
[4] Id. ex. Agatharchide. III. p. 183.

mixture of substances capable of combining, so as to produce them during the process of refining the precious metals, and therefore whether they were not accustomed to separate gold from silver, or other alloy, through the action of these acids, which, attacking the foreign matters contained by the ore, left the gold pure.

The process, described by Theophrastus, which was employed in order to procure quicksilver from native cinnabar by rubbing the ore in a brass mortar, with a brass pestle, with ὄξος, has been remarked, p. 56. Theophrastus adds, "And many other things of this kind other persons, perhaps, may attain."[1]

Pliny is more explicit, or rather the science had advanced since the Greek had written, and the prediction of Theophrastus had apparently been fulfilled.

In the chapter upon gold, L. 33. C. 4, Pliny hands down this remarkable sentence.

"Torretur etiam cum salis grumo, pondere triplici misto, et rursum cum duabus salis portionibus, et una lapidis, quem schiston vocant: ita virus tradit rebus unà crematis in fictili vase, ipsum purum et incorruptum."

"It is also calcined with salt grumus, mixed in threefold weight, and again with two portions of salt and one of a stone which they call schistus: thus, the substances being burned together in an earthen vessel, the *bitterness* yields it pure and uncorrupted."

Should the "sal grumus"[2] be the sulphate of potash, (*Glauber's salt,*) this, with the schiston, acting upon the common salt (muriate of soda,) with the presence of water, yielded by the salts and alumine, would, under the action of heat, yield a muriatic or hydrochloric acid, called in after times "the spirit of salt," the gold would be liberated, the sulphur combining with the soda, alumina, &c.

The schiston was of many kinds, one a sort of hæmatite, another of anthracite, but a third a species of calcanthus, or sulphurous copper ore, from which a schiston was made, called by Pliny a concrete alum—this is no other than our chrystallized sulphate of copper[3].

Geber has the credit of the invention of the mineral acids, yet he writes as if he were not the inventor, but rather the compiler of

[1] Theophrastus on Stones. C. 105. "Τὰ μὲν οὖν τοιαῦτα τάχ' ἄντις λάβοι πλείω."

[2] Glumen rotundundum, et salvandum quod sal Gemma vocatur, et calcanthum ex aceto acerrino terunter in æreo mortario, &c. "Eraclius," vide Raspe, p. 116. Thus grumus or glumen is not "sal gemma" (muriate of soda).

[3] Compare Pliny. L. 35. C. 15. with L. 34. C. 12.

the processes he indicates, and it is probable that he, as well as the other Arabian authors, drew largely from Greek sources of information, now lost to us.

Geber directs a mixture of 1 ℔ of vitriol of Cyprus, 1½ ℔ of saltpetre, and a quarter of alum of Jameni, to be submitted to distillation in order to procure a liquid of great solvent power[1]. He adds that if you supply a quarter of sal ammoniac to this it will dissolve gold[2]. The vitriol of Cyprus is a sulphate of copper; the nitrate of potash and muriate of ammonia (sal ammoniac) reacting upon each other form the "aqua regia," or mixture of nitric and hydrochloric acid, the sulphuric acid combining with the salifiable bases.

In c. xxxiii. Theophilus directs that the uric salts and common salt be mixed with clay for the purpose of purifying gold.

C. XXIV. MARCA, NUMMUS.

The Marc contained eight ounces—"octo unciæ faciunt marcam." (Skenœus, de ponderibus et mensuris.)

The Nummus varied, there were nummi of copper, the penny —of silver, the denarius, ten pence—of gold, twenty-five denarii.

In weight the nummus was sometimes the fourth part of the silver denarius; sometimes it is placed for the drachma, or ⅛th of a Roman ounce.

C. XXVI. "DEXTER, SIGNANS."

The "guide of painting," Ἑρμηνία τῆς ζωγραφικῆς, from Mount Athos, describes the manner of representing this emblem, so frequently found in the decorations of both Greek and Roman churches; but the mode of expressing the benediction differed with the sects.

"When you would represent the hand giving benediction do not join three fingers together, but cross the thumb with the fourth finger, so that the second, called the index, remaining straight, and the third being a little bent, they form together the name of

[1] Nitric acid.

[2] Geber de Alchem. Norimb. 1545. C. xxiii.

Jesus (IHCOYC), IC. In effect the second finger, remaining open, indicates I (iota), and the third forms, by the curve, a C (sigma). The thumb is placed across the fourth finger; the fifth is likewise a little bent, which forms an indication of the word (XPICTOC) XC; for the meeting of the thumb and the fourth finger forms a X (chi), and the little finger forms, by its curve, a C (sigma). These two letters are the abridgment of CHRISTOS. Thus, through the divine providence of the Creator," continues the monk, "the fingers of the hand of man, be they more or less long, are arranged to be so as able to design the name of Christ."[1]

"The western Church," writes M. Didron, "is less mystic. The benediction is made in opening the three first fingers of the right hand, and in keeping the annulary and the little finger shut. It is true that certain liturgists, Guillaume Durand, amongst others, say (Rationale divinorum offic. l. v. c. 2.) that "this mode of blessing recalls the Trinity."

"In the church of Mount Hymettus, the Father blesses by opening only the great finger and index; but this may be an error, and I, perhaps, imperfectly saw it. It is possible that a Greek benediction may be met with amongst us; such a fact should be established with the utmost care, as incontestably proving a Byzantine influence. M. Aymard has found, in the cathedral at Puy, a hand blessing in the Greek manner. "This church," says M. Didron, "is vaulted with cupolas, as a Byzantine church, and proves that the ancient churches with cupolas are really Byzantine, although not the only ones."

C. XXVIII. DE NIGELLO.

The beauty of the chalice, designed by Theophilus, will not escape the attention of the artist, nor will the value of the recommendation to "carve with a bold stroke" in the preparation of the ground for the "niello" be lost. The value of this and the 26th chapters will be seen by those who will take the trouble to compare them with the readings of all other copies of the MS. of Theophilus.

The Roman casket of silver, enriched with niello, found at Rome in a ruin near the Esquiline gate, and which was of the 4th

[1] Manuel d'Iconographie Chrétienne. Gr. et Lat. Paris, 1845. Didron et Durand.

or 5th century, proves the antiquity of this species of ornament. This casket contained the utensils necessary to the toilet of a Roman lady, and bore an inscription to the effect that it was given by Turcius secundus to Projecta, his wife. See M. Visconti. "Lettera su di una antica argentaria," &c.—Roma, 1793[1].

C. XXIX.

"Take the gum which is called parahas, or barabas."

In the manuscripts of the 13th and 14th centuries the chrystallized salts are sometimes called gummi. The chrystallized urates are called by Paracelsus "Barnabas, or Barnaas," which he describes as the "sal petræ urinarius; urina salis petræ."

Barach, borak or borax, the native borate of soda, began through the Arab chemists, or alchemists, to be distinguished in the arts from the 9th century.

The Montpellier MS., already quoted in the notes to L. 1, gives the composition of nigellum which is to be used with "boraxa" as a flux; the composition of the niello is from silver, copper, sulphur, and lead; the same materials, although in different proportions, as those of Theophilus, borax is therefore probably intended by him. I give the extract:

L. 4. "DE NIGELLO.

"Accipe plumbum, erame, argentum similiter; confla equales partes: ipsis in igne conflatis, cum carbone vivo misce, postea addite sulfur, quantum ut per totum sint ista metalla et misce cum carbone vivo, coque sulfur, et cum combustum fuerit, projice in aliquo loco ubi sit aqua clara, et cum 'boraxa' distempera, et scribe in curvaturis quicquid vis."

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[1] "HOW TO MAKE NIELLO.

"When you wish to make niello, take equal parts of quicksilver, copper, and lead, and put them in a vessel that they may cook together. Then take of sulphur, the weight of six denarii, and mix it with them and stir it. Afterwards withdraw it from the fire and allow it to become cold, place it in a vase and take atramentum, tempered with wine, and make what you wish upon silver with the atramentum, and immediately overlaying the powder of quicksilver, copper, and lead, and then melting it, a beautiful niello may be made."—*Ab Eraclio. Ms. Le Begue. Paris. Art.* 251.

"OF NIELLO."

Take lead, copper, likewise silver, melt equal portions; being burned, mix them with live charcoal, afterwards add sulphur, as much as is the total of the metals, and mix with the live charcoal, cook the sulphur, and when it has been calcined, cast it anywhere, where there is clear water, and mix it with "borax" and paint what you wish in the circles.

C. XXXI.

Take wine-stone, "tollevini petram."

The lees of wine (*fæx vini*) were burnt by the ancients, and the cinders, being preserved, were applied to the same purposes as the potash, or soda, the cinders of vegetables. "Cinis fæcis vini nitri naturam habet, easdémque vires, hoc amplius, quo pinguior sentitur."[1] The lixivium of this ash, freed from impurities, and again evaporated, produced the wine-stone of our author, the bitartrate of potass, or cream of tartar, of commerce. It is here directed to be used as a flux, as is the borate of soda in chap. 29. (see notes to L. 2. on glass-painting.)

C. XXXII.

The reader will remark the operation of enriching the silver chalice with niello, how closely it resembles the preparation of an engraved plate for printing. It is said that the accidental impression, or proof of the nielled pax of Finiguerra was the origin of copper-plate printing. Upon turning to C. LXXI., the process described by Theophilus, for blackening or nielling copper, which led to the art of printing from an engraved copper plate, is nearly a description of the art itself. Two impressions of the pax exist in Paris, one at the Bibliothèque Royale, another at the Bibliothèque de l'Arsenal.

C. XXXV., XXXVI., XXXVII.

The mixture of quicksilver with the powder of gold aided the

[1] Pliny, L. 14. C. 20.

mechanical process of gilding after the working and polishing of the enamels or glass gems, a process which, says the Abbé Texier, is always observable in the Romaic gilt and enamelled work; submitted to a moderate heat, sufficient for the sublimation of the mercury, the "electra," or glass gems remained uninjured. The whole process is worthy attention as is the preparation for receiving the gilding called "invivare," by Theophilus, consisting of bitartrate of potass, muriate of soda, and quicksilver.

C. XL. "OF COLOURING GOLD."

The process here described is calculated to produce the same action upon the surface of an impure gold as that followed by submitting it to the action of a diluted muriatic acid. Atramentum, or the sulphate of copper, (or iron,) having been partly deprived of the sulphuric acid it contains, is again subjected to heat in the presence of muriate of soda and the uric salts, upon the surface of the gold to be purified. The result would form a certain proportion of muriatic acid which, removing the alloy it might contain, would render the gold pure, thereby colouring, or rather de-colouring the metal.

C. XLV. DE FISTULA.—OF THE PIPE. [1]

The reed, called also syphon, canna, calamus, etc., was an instrument formerly used in the Roman church in the service of communion, in order to withdraw the wine from the chalice for fear of spilling it.

Its use was preserved during a long time in many monasteries[2]; at Cluny, at St. Denis[3], in the ceremonies of the consecration of the Kings of France[4]: now the Pope alone employs it in the celebration of Roman ceremonies.

The Benedictines, authors of the "*Voyage Litteraire,*" describe a reed, which they saw in the treasury of the Abbey of Corbie:

[1] Note, by the Count de l'Escalopier.

[2] Bona, *Rer. Liturg.* L. 1. C. 25. N. 4. Op. Antwerp. 1793.

[3] De Moléon (Le Brun des Marettes), *Voy. Liturg. de Fr.* p. 149.

[4] Cancellieri, *De Secretariis.* T. 4. p. 1789. *Sylloge vet. monum.*

"It had a small cup to receive the precious liquid which might fall through accident, from which, in such case, it would fall back into the chalice by two small tubes. The instrument was sometimes fixed to the chalice."

The reed was unknown to the Greeks.

"They break many small pieces of the consecrated bread, which they place in the chalice. They have a small spoon with which the priest takes one of these small pieces dipped in the wine, and he thus gives it to the communicants. It is only to the priests and clerks assisting at the Liturgy that they give the chalice. The Greeks assert that St. John Chrysostome established the use of this spoon, but there is no certain proof amongst the ecclesiastical writers. According to the legend it was thus, that about the year 400, a solitary saint of Egypt received a miraculous Eucharist which was brought to him by angels.

"The spoon was consecrated as well as the chalice and patena. This instrument, unknown to the Latins, as was the reed to the Greeks, is not mentioned by Theophilus, who has in view only the pomps of the Western Church."

C. XLVIII. DE AURO HISPANICO.

When the smile, excited by the language of those who followed the sacred science, "ἐπιστήμη ἱερα," or chemistry, shall have passed, we shall probably be anxious to search into the meaning of our author.

The Egyptians, according to all authorities, practised the science at a remote period, and it was in their schools that the Greeks and Arabs were initiated into the sacred science, the revelation of the mysteries of which was, at one time, punished by death.

Theophilus, who informs us that "the skilfulness of the *Gentiles* in this art is probable," is doubtless alluding to the Arab alchemists of Spain, who at an early period pursued the sciences acquired from the Greeks and Egyptians.

The process which Theophilus describes in this symbolic language, appears no other than that for procuring a pure gold by the means of the mineral acids. Let a solution of gold be made by nitro-muriatic acid and copper be introduced, the latter would be dissolved while the gold would re-appear, but in a state of purity, or, as the alchemists would have expressed it, the *copper would*

have been transmuted into pure gold, "donec ipsa confectio cuprum transmordeat, et inde pondus et colorem auri suscipiat."

We have already seen that the ancients were aware of the action upon metals of substances calculated to produce the mineral acids in the art of refining, and that the Arab alchemists have described these acids in unequivocal terms.—Numbers, letters, the signs of the zodiac, animals, plants and organic substances, form the symbolic vocabulary of the alchemists of this period. The basilisc, the dragon, the red and green lions, were the sulphates of copper and of iron; the yellow lion, of the yellow sulphurets; the black eagle, the black sulphurets; the red lion was sometimes cinnabar; the salamander, fire; milk of a black cow, mercury; the egg, gold; the red dragon, cinnabar; &c., &c. Unfortunately each chemist appears to have varied the symbols in use[1].

The toad, "ugly and venomous, bears yet a PRECIOUS JEWEL in its head,"[2] the toads of Theophilus which hatch the eggs, are probably fragments of the mineral salt, nitrate of potash, which would yield one of the elements of the solvent for gold; the blood of a red man, which has been dried and ground, probably a muriate of ammonia; fine earth, a muriate of soda (common salt); the cocks, the sulphates of copper and iron; the eggs, gold ore; the hatched chickens, which require a *stone pavement,* sulphuric acid produced by burning these in a stone vessel, collecting the fumes; these are then all digested together tempered with a sharp acid. The elements of nitro-muriatic acid are all here, the solvent for gold.

Geber tell us that the salt drawn from the ashes of a mole will convert copper into gold. "Sal totius talpæ combustæ congelat Mercurium et Venerem convertit in Solem, et Martem in Lunam."

[1] See Ath. Kircheri, *Œdip. Ægypt. Roma,* 1653, Vol. 2. Jamblicus, *de vita Pythagorica,* Leyd. 1570. Idem, *de mysteriis Ægyptiorum, Leipsic,* 1815. Ol. Borrichius, *de Cabala characterali dissert.,* Leyd. 1649. Idem. *Hermatis Ægyptiorum et Chemic. Sapientia.* MSS. Sloan. 3640. 3751. 3772. 2459. 3506, &c. Bib. Royale, Paris, MSS. 2329. 2250, &c. Arcanum Hermeticæ. *Anon. Geneva,* 1653. Hoefer, *Hist. de la chimie.*

[2] It is not the drowning man only who "catches at straws." The mind of Shakespear would grasp at and weave a beautiful simile from the meanest object. That Shakespear was acquainted with the jargon of the Alchemist, who can doubt? The "basilisk" of Lady Anne, the "confection" of the Witches, show this, as do the works of his contemporary, Jonson.

C. LII. SMIGMA.

From Σμαώ or Σμήχω—σμῆμα—"id quo ad abstergendum et purgandum utimur."

C. LIV. DE ELECTRO.

The electrum of our author is neither amber, nor the mixture of silver with gold, to the amount of one fifth part, ("Omni auro inest argentum vario pondere; ubicunque quinta argenti portio est, electrum vocatur,"[1]) which was called by the Greeks "electron." It is that kind of uncut glass gem which is so frequently found as a decoration upon coffers, pyxes and crosses, of the tenth to the fourteenth centuries. The origin of the term is probably explained by Aldrovandus (*note* 1, *p.* 65 *of this work*). Theophilus is careful in his directions for making these gems; it is a process of enamelling, set in filagree work (see C. LII.); a distinction is also made between the "lapis," which is an opaque stone of rare kind, and the "electrum," the transparent stone; these are to be alternated in the setting, the opaque stone being ornamented by a border of pearls[2].

C. LXI. "THE EVANGELISTS, WHETHER IN LIKENESS OF ANGELS OR FIGURES OF ANIMALS."

By the Quinisext council, held at Constantinople A.D. 692, the Christian artists were recommended to prefer reality to allegory, and were ordered to represent Christ upon the cross. The Greeks had previously portrayed Christ under different allegorical forms — the Good Shepherd, as Orpheus disarming Cruelty by means of the suavity of his accents: as the new Daniel, naked amongst the Lions, which are disarmed by his grace: as Phœnix, conqueror of the Spirits of Darkness, &c., &c. The pictures brought from Rome by Biscops, during the papacy of John V., A.D. 686, appear, as stated by Bede, to have been of this class. "Imagines

[1] Pliny, L. 33, C. 4.

[2] A pyx, of the eleventh century, was lately shown me, ornamented in this manner.

quoque ad ornandum monasterium ecclesiamque Beati Pauli nostri, de concordia Veteris et Novi Testamenti summâ rationê compositas, exhibuit. Verbi gratiâ, Isaac ligna quibus immolaretur portantem, proximâ super invicem regionem picturâ conjunxit. Item serpenti in heremo à Moyese exaltato, filium hominis in cruce exaltatum, comparavit."—Vener. Beda. Hist. Ab. Wiremuth. L. 1.

The four rivers of Paradise "in human form," and the Evangelists "in figures of animals," are a remnant of the iconography of this period.

The Athos manuscript shows us how the Greeks, in the twelfth century, represented the Evangelists; these representations, probably, date from the middle of the ninth century, when art began to recover from the effects of the persecution suffered by the Greek painters owing to the proscription of religious images pronounced by Leo the Isaurian. This persecution lasted about 150 years [1].

"THE FOUR EVANGELISTS."[2]

Saint Matthew the Evangelist, as an old man with a long beard' writing "Book of the genealogy of Jesus Christ, Son of David.

Saint Mark, with grey hair and round beard, writing "The beginning of the Gospel of Jesus Christ, Son of God, as it is written."

Saint Luke, young, crisped hair, little beard, writing "Forasmuch as many have undertaken."

Saint John, the Theologos and Evangelist, an old man, bald, large thin beard, seated in a cave: he turns the head back towards the heavens, the right hand upon the knees, the left extended towards S. Prochoros[3]. Prochoros is seated before St. John writing these words, "In the beginning was the Word, and the Word was with God."

Before the evangelists the Tetramorphe[4] animals, with wings holding the Gospel: they turn their looks towards the four evan-

[1] See Emeric David. P. 114, et seq.

[2] Manuscript from Mount Athos. Didron. Paris. 1845.

[3] Prochoros is a clerk, who every where accompanied St. John, and who often wrote under his dictation.

[4] The Tetramorphe is the union of the four attributes of the evangelists in one figure, one body united to four heads. The angel of St. Matthew, the eagle of St. John, the lion of St. Mark, and the bull of St. Luke, have the heads grouped upon a winged human body, the four gospels forming one. The Tetramorphe, says M. Didron, is rarely seen in the iconography of the western church, but is frequent in the Greek. τετρά μορφή—four-form.

gelists, as follows. Towards St. Matthew, the man; towards St. Mark, the lion; towards St. Luke, the bull; the eagle towards St. John.

Interpretation:— The likeness of the man signifies the incarnation; of the lion, power and royalty; of the bull, preaching and sacrifice; of the eagle, of the inspiration of the Holy Ghost. You must know, also, that St. Matthew, St. Mark, and St. Luke are represented in apartments while they write; but that St. John is represented in a cave with Prochoros.

C. LXI.

"You will adapt to each Apostle a corresponding prophet, that their testimonies may agree," writes Theophilus.

Our author, who, it has been seen, wrote for the provision of the ceremonies of the Roman church, is anxious that this early branch of Christian iconography should not be neglected. Theophilus has afforded us so few points by which we may be enabled to trace the period at which he wrote, that these few words, hitherto neglected, should certainly be considered if at all bearing upon that question.

Mons. Didron, who has paid as much, if not more, attention to the history of Christian art as any author, and whose researches in Greece have so qualified him for judging upon this branch of archæology that his opinion may be accepted as authority, declares that the higher we mount into the history of Christianity, the more we find the Judaic influence prevail. "The western church, in France in particular, ended by withdrawing itself from this Oriental embrace, but traces of it are found in the most ancient of our monuments and liturgy." St. Moses, St. Samuel, St. Daniel, St. Elias, St. Jeremiah, St. Isaiah, all the holy patriarchs, prophets, and teachers of the law, figure in the ancient litanies. "In the cathedral of Strasburg, upon the ancient glass, some of which dates even from the eleventh century, Isaiah is seen with the nimbus, like a saint of the New Testament. Strasburg," he adds, "is German, and Germany owes much to Byzantium. The Greek Church honours the saints of the Old Testament as much as those of the New, therefore the patriarchs, prophets, judges, and kings of Judah, occupy an important place in the Byzantine paintings."

In the public library at Amiens is a manuscript believed to be

of the ninth century, but which, says M. Didron, is certainly anterior to the schism consummated by Michael Cerularius; it is a book of psalms. At the end of the MS. is a prayer, a litany where all the orders of saints, apostles, &c., are successively invoked. Immediately after the angels and before the apostles the patriarchs and prophets are one by one invoked. Saint Abraham, St. Moses, St. Aaron, St. Samuel, St. David, St. Amos, St. Habbacuc, &c. But in the eleventh century this fraternization ceased, and the respect which had until then existed in the Roman church for these personages diminished, the Latins "became rather disdainful of the Old Testament."

Theophilus, who gives few iconographical descriptions, by his careful directions for a practice, by which the prophets of the Old and the apostles of the New Testaments are fraternized, should have lived at latest in the commencement of the eleventh century[1].

C. LXIII. CALAMINE.

The calamine or cadmia of the ancients, which Pliny tells was used in the manufacture of brass, "lapis, ex quo fit æs, cadmia vocatur,"[2] is the rough zinc ore; Dioscorides informs us that cadmia is produced during the calcination of brass, and that it attaches itself upon the sides of the furnace[3].

[1] This respect, which the Roman church gradually lost for the holy characters of the Old Testament, and which M. Didron designates as the "Judaic influence," has been perpetuated amongst us in England, which has also otherwise been so strongly impressed by the Byzantine genius.

Our finest Gothic cathedrals are upon the plan of the double or Greek cross; our liturgy greatly imbued with the writings of the Greek Fathers.

I insert a note of the learned M. Durand, upon the effect of Jewish and Byzantine influence upon England. It is singular, that no sooner does a Frenchman approach any subject with which England is connected, than his ideas seem to run riot. There is, however, some truth in the following. "The names of Adam, Isaac, Jacob, Abraham, Moses, David, Solomon, &c., are very common in Greece; there is Jew in all that. It would seem that Byzantium, nearer than Rome to Jerusalem and the Holy Land, has not been sufficiently capable of escaping from the Old Testament. *What it is proper to remark is, that England, Jewish by commerce, is Jewish and Byzantine in her religious customs. Bentham is called Jeremiah; Reynold, Joshua; Newton, Isaac; Garrick, David; O'Connell is called Daniel.* St. George, the patron of Greece, and to whom the patriarchal church at Constantinople is dedicated, is patron of England. England gives this name to the branch of the sea which separates her from Ireland. *The celebrated Canning was called Georges.*"

[2] Pliny, Hist. Nat. L. 34. C. 10.

[3] Dioscor. Mat. Med. L. 5. C. 84.

The difference between "æs" and "aurichalcum," both a brass, is taught us by Theophilus; "æs" is the mixture of calamine with unrefined copper—"aurichalcum" is made with very pure copper, because it can then be gilt. C. 66.

Bell metal is made by adding a fifth of tin to melted copper. C. 63.

Theophilus speaks of Spanish brass, as used in thin plates in stamped work. This, being gilt, is probably a thin plate of copper coated with gold by the process described in note to C. 48, p. 432.

C. LXXII. INTERRASILIS OPUS.

Critics have differed as to the interpretation of this word. "Quod nunc scripturis nunc planitie variatur; hoc, et non aliud, opus, interrasile dicas."—Alex. By this would be intended an engraved work, varied with plain surfaces. It has been called "Anaglypha Scriptura," carved work. Muratori thought that it applied only to the species of engraving in the manner of seals. "Quo nomine opinor, non omnem cælaturam designari, sed eam tantum, quæ incidendo figuras efformabat, ut est in sigillis." (V. 2, p. 360.) Theophilus, in designating this as Arabian work, has caused Emeric David[1] and M. de l'Escalopier[2] to think that the word interrasilis means Damascus work, "*damasquinure*," or the threaded gold or silver work seen upon the sabres, pistols, cuirasses, &c., of the east. We fortunately possess a chapter in this MS. in which this latter art is carefully detailed; the damascine work is described in one of the chapters hitherto unknown, C. 90.

The opus interrasilis, then, is an engraved or sculptured plate, the plain grounds of which are cut out with the chisel, or "meizel," in the German. Our ancient English brasses are of this nature.

C. LXXV. OF STAMPED WORK.

This branch of industry has already been followed in France since the publication of Theophilus by the Count de l'Escalopier in 1843. I have seen some bold and handsome designs from Paris, executed in thin gilt copper, in this fashion, well calculated

[1] Emeric David. Theophilus. Biograph. Univers.

[2] Theophili Opera. Paris. 1843. Le Cômte de l'Escalopier.

for picture frames, if fitted to wood, or for ornamenting apartments, &c. A simple lever, fitted upon a tall upright post, with a weight attached to one end, is the stamp employed; the other extremity of the lever is pulled by a rope. Our Birmingham and Sheffield manufacturers could, were proper designs procured from our artists, defy all attempts at competition, and re-establish a neglected source of profit and industry.

C. LXXXI. "DE ORGANIS."

It will be seen that the Harleian MS. of Theophilus enriches the archæologist with three new chapters upon the construction of the organ, which seems in the time of our author to have been of a simple construction.

David, in the cl. Psalm, speaks of the organ, which does not appear to have become known to Western Europe until the year 757, when one was sent as a present to Pepin-le-Bref, by the Emperor Constantine Copronymos.

In a rare Saxon manuscript of the eleventh century,—Cotton, Tiberius, B. 6, page 18, is a drawing of the "BUMBULUM cum fistula ærea," with brass pipe; also another description of "brass bumbula, with the pipes placed in the middle, three bumbula placed on every side." This BUMBULUM appears to be an organ, which is sounded by withdrawing the stops, being, as the organs of Theophilus, unfurnished with keys. The pipes are of very thin and pure copper.

In a notice of the "Church of the Holy Cross," at Binstead, Isle of Wight, by Mr. Withers—(Weale's Quarterly Papers on Architecture, Midsummer, 1845,) which church is of early Norman erection, a recess in the wall on the north side of the chancel remains unexplained, as that gentleman states that no traces exist on the outside wall to show that a sacristy has ever existed there. Similar recesses are found in our early Norman churches elsewhere, one in the church at Beaulieu, Hampshire, if I am not mistaken.

A probable solution of the use to which these recesses were applied is found in the 83 C. "Si volueris organa ultra maceriam muri stabilire, ita ut infra monasterium nihil appareat," &c. They were for the purpose of a proper arrangement of the organ and the seat of the organist, at that time the chanter also.

C. LXXXV.

In completing the directions for the services of the church, Theophilus does not omit the foundry for bells, of which a minute description is given. Four parts of copper and a fifth of tin form the composition of the bell-metal. Four openings are made near the neck, "that it may sound better,—ut melius tinniat"—this precaution is often, in our day, neglected.

CC. LXXXVI. AND LXXXVII. DE CYMBALIS MUSICIS.

The translation of the 86th chapter presents difficulties which will be allowed by all who consult the original manuscript. I have strictly followed the text.

This Hebrew and ancient Greek instrument of joy and worship was introduced into the ceremonies of the Byzantine church. They were employed at the celebration of the fêtes of Cybele, to whom the invention is attributed. David, in the cl. Psalm, speaks of the loud cymbals and the high sounding cymbals.

The cymbal was discontinued upon the improvement of the mechanism of the organ, which, however, still possesses traces of of the ancient accompaniment of that instrument, one part being divided into the *great and second cymbal.*

The alloy of the cymbals of Theophilus is about a fifth or sixth part of pure tin to one of pure copper.

C. XC. DE FERRO.

This curious chapter upon iron exposes the ancient manner of inlaying steel with gold and silver, known to be of Damascus origin; this process, as that of the interrasilis, is of that work which "distinguishes Arabia," and which Theophilus promises in the chapter to the first book.

C. XCII. OF SCULPTURING IVORY.

This is one of the Italian arts of the period, mentioned also in the Preface to the first book.

The "huso" is the sturgeon. M. de l'Escalopier remarks that this word, of Germanic etymology, may strengthen the belief in the Germanic origin of our author.

The ancients had a method of softening and bending ivory by immersion in different solutions of salts in acid. Eraclius has a chapter on this. "Should you wish to bend ivory and ornament it." Take sulphate of potass, (*glumen rotundum*[1],) fossil salt, (*sal gemma, muriate of soda,*) and vitriol, (*calcanthum, sulphate of copper,*) these are ground with very sharp vinegar in a brass mortar. Into this mixture the ivory is placed for three days and nights. This being done, you will hollow out a piece of wood, as you please. The ivory being then placed in the hollow you direct it, and will bend it to your will.

In the MS. Sloane, 416, p. 40, already quoted, is a similar recipe, with the addition that these matters are to be distilled in equal parts, (per alembicum,) this would yield muriatic acid, with the presence of water; the MS. adds that "infused in this water half a day, ivory is made so soft that it can be cut like wax. And when you wish it hardened, place it in white vinegar and it becomes hard."

C. XCIII. RUBRICA.

The rubrica, or rubea radix, was the ἐρυθρόδανον of the Greeks; the red root, or madder.

Walnut oil is here alluded to as used in the arts for the purpose of preserving ornaments in ivory.

C. XCIV. "CHRISTALLUM."

That crystal was a stone produced by the long continued action of cold upon water is but the opinion of Pliny, perpetuated by our author. "Contraria huic causa crystallinum facit, gelu vehementiore concreto. Non aliubi certè reperitur, quam ubi maximè hybernæ nives rigent: glaciemque esse certum est: unde et nomen Græci dedere." Plato taught that condensed water became ul-

[1] Should this "glumen rotundum" be a *nitrate* of potass, another active element would be added to this composition.

timately transformed into stones and earth, and Thales, before him, that "water is the principle, or origin, of all matter."

The word "tentura," again of Germanic etymology, would show, that if not German, Theophilus wrote for the instruction of that people. Isca, which I have rendered tinder, properly means the pith, or "medulla" of plants, which was also used for the ready production of fire.

"Ismaris lapis" I have translated "emery," as the Σμίρις λίθος of Dioscorides and Hesychius, anciently known for cutting and polishing gems.

C. XCVII. WOAD.

The corn poppy was much used in order to produce a blue vegetable colour for illuminating, before the introduction of indigo, which gradually superseded it. "Endico" was a name, however, given to the blue colour produced from woad in imitation of indigo, as late as the 14th and 15th centuries in Italy; see MS. Sloane, 416, p. 134. "A Fare Endico. Toy fiore de guado e creta biancha, poy toy dele granele de lebio qũ sono ben mature, e toi rane e fali bolire al fuoco tanto che siano chote, e poi le spumi e deguela spremitura getano sopra le dite polvere;" &c.

C. XCVIII. DE LACCA.

The lake of the Greeks, probably so called from λακκός, a hollow, or cut, was made, Eraclius and our author inform us, by making an incision in the ivy in spring, and boiling the sap, which exudes, with urine.

The "phœnix color," or phœnicia, or fenicon, is a red or rosy colour, probably made from the oster, and the Tyrian red; for which this lake was substituted.

C. CVI. CANDIDUM SULPHUR.

The "three kinds of sulphur, white, black, and yellow," mentioned by our author, L. 1. c. 36, were not always the metal Sulphur in various states of purity.

The "pompholyx" of the ancients, which was produced by the

calcination (in a close vessel fitted with an upper chamber) of brass or of calamine, appears to have been the white sulphur of the Byzantines and Arabs. Both these substances generally contained arsenic, the volatilization of which, with that of the zinc, would produce a mixture of the oxides of arsenic and zinc; the deposition in the lower chamber, of a darker colour and less pure, were combinations of the zinc with other substances, according to the nature of the ore calamine employed, and was called spodium [1].

Geber tells us that "arsenic is composed of subtle matter, and is of the nature of sulphur; it is *fixed* by the metals, like sulphur, and like it is produced by the calcination of the metals:" (is not this the white sulphur of the Greeks?) "Therefore it is not proper to be classed (diffiniri) otherwise than sulphur."[2]

Albertus Magnus, whose writings are in great measure a *resumé* of the Greek and Arab chemists, tells us that brass will yield arsenic; "æs expirabit arsenicum."[3]

The θεῖον λεῦκον, white sulphur, was that which produced white brass: Olympiodorus knew that arsenic gave a white colour to copper, and he calls it *a kind of sulphur* which is volatilized by the action of fire. *MS. 2250, Bib. Royale, Par.*

Richardus Anglicus, who appears to have been contemporaneous with Roger Bacon, tells us that "white sulphur fixes (*coagulat*) quicksilver;" he adds that "there is no sulphur in silver but the white sulphur."[4]

An impure mixture of oxide of arsenic with zinc or tin, would, mixed with white glass, yield an opaque flux, proper for painting on earthenware.

DE MIXTURA COLORUM.

MAPTIZABIS, a Romaic term from "Mappa," a drawing, or picture.

[1] Pliny. L. 34. C. 13.

[2] Geberi Opera, "de arsenico." C. 29.

[3] Albertus Magnus, de rebus metallicis.

[4] The edition of Geber, printed at Nurimberg, 1545, contains a treatise of "Richard, the Englishman," upon alchemy. See C. 12, of that treatise.

FINIS.

INDEX.

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29

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